STAT 139: Final Project

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EDA

```
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
# Load team data
team_data = list()
team_wins <- list()
drop = c("W", "L")
for (year in 1997:2022) {
  df1 = read.csv(paste("data/teams_data/batting", year, ".csv", sep=""))
  df2 = read.csv(paste("data/teams_data/pitching", year, ".csv", sep=""))
  df3 = read.csv(paste("data/teams_data/fielding", year, ".csv", sep=""))
  df_tot = merge(merge(df1, df2, by="Tm", suffixes=c(".bat", ".pitch")), df3, by="Tm", suffixes=c("", "

  df_tot = df_tot[
    !(df_tot$Tm %in% c("", "League Average")),
    !(names(df_tot) %in% drop)
  ]
  df_tot$Tm = factor(df_tot$Tm)
  team_data[[year]] = df_tot
  team_wins[[year]] = df_tot[, c("Tm", "W.L.")]
}

# Load player data
years <- 1997:2022
bps <- c("batting", "pitching", "fielding")
player_data <- list()
for (year in years) {
```

```
  player_data[[year]] <- list()
  for (bp in bps) {
    player_data[[year]][[bp]] <- read.csv(paste("data/player_data/", bp, year, ".csv", sep=""))
    quant_cols <- names(select_if(player_data[[year]][[bp]], is.numeric))
    for (col in quant_cols) {
      # impute data with mean
      df <- player_data[[year]][[bp]]
      player_data[[year]][[bp]][is.na(player_data[[year]][[bp]][,col]),col] <- mean(df[,col], na.rm=TRU
    }
  }
}

fa_data = list()
for (year in years) {
  fa_data[[year]] = read.csv(paste("data/fa_data/fa", year, ".csv", sep=""))
  fa_data[[year]]$WAR3[is.na(fa_data[[year]]$WAR3)] = 0
}
```

```
# Data Cleaning for the Team Data
team_wins <- list()
for (year in years) {
  team_wins[[year]] <- team_data[[year]][!(team_data[[year]]$Tm %in% c("", "League Average")), c("Tm", 
}
```

```
# Clean player data
for (year in years) {
  for (bp in bps) {
    player_data[[year]][[bp]]$year <- year
    player_data[[year]][[bp]]$year_adj <- year - 1997
  }
}

for (year in years) {
  player_data[[year]][["pitching"]] = player_data[[year]][["pitching"]][!is.infinite(player_data[[year]]
}

long_team_names <- team_data[[year]][!(team_data[[year]]$Tm %in% c("", "League Average")),]$Tm
short_team_names <- c("ARI", "ATL", "BAL", "BOS", "CHC", "CHW", "CIN", "CLE", "COL", "DET",
                      "HOU", "KCR", "LAA", "LAD", "MIA", "MIL", "MIN", "NYM", "NYY", "OAK",
                      "PHI", "PIT", "SDP", "SFG", "SEA", "STL", "TBR", "TEX", "TOR", "WSN")
agg_data <- list()
for (year in years) {
  agg_data[[year]] <- list()
  for (bp in bps) {
    quant_cols <- names(select_if(player_data[[year]][[bp]], is.numeric))
    agg_data[[year]][[bp]] <- player_data[[year]][[bp]][, c("Tm", quant_cols)] %>%
      group_by(Tm) %>%
      summarise(across(quant_cols, ~weighted.mean(., w = G)))
    agg_data[[year]][[bp]] <- agg_data[[year]][[bp]][!(agg_data[[year]][[bp]]$Tm == "TOT"),]
    agg_data[[year]][[bp]]$long_Tm <- factor(
      agg_data[[year]][[bp]]$Tm,
      levels=short_team_names,
      labels=long_team_names
```

```
    )
  }
}
```

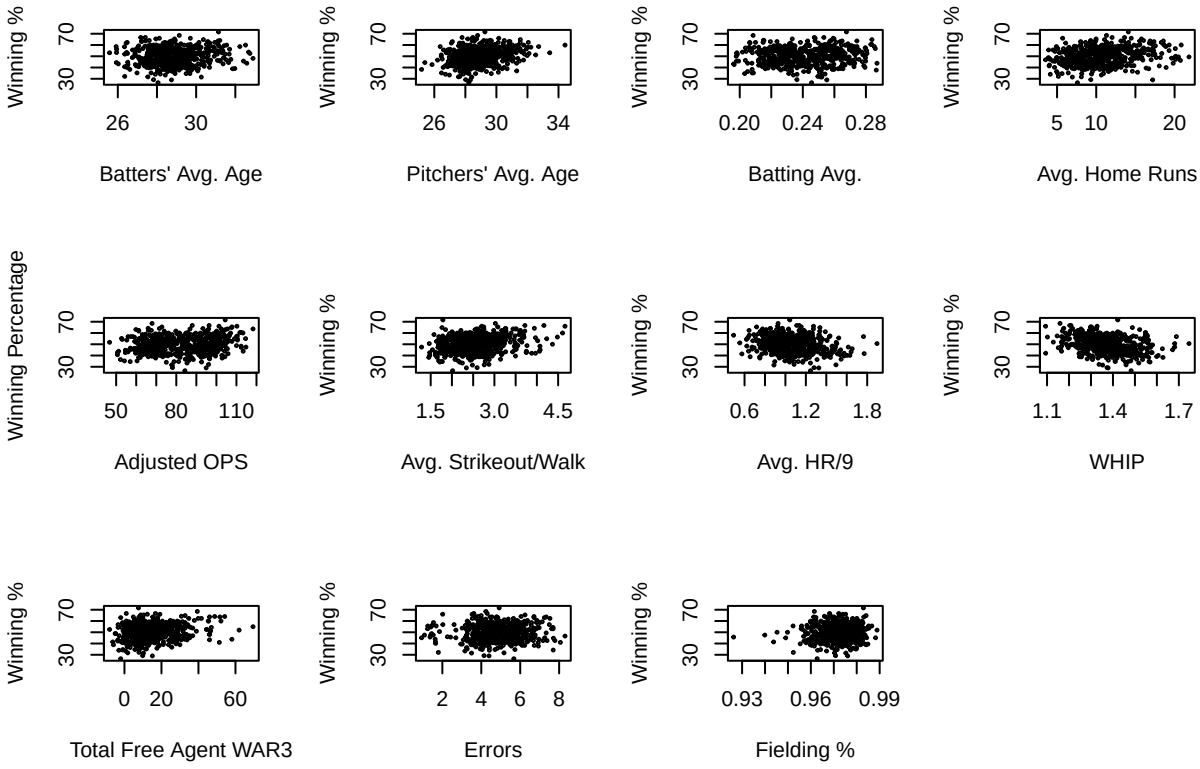
```
## Warning: Using an external vector in selections was deprecated in tidyselect 1.1.0.
## i Please use ‘all_of()‘ or ‘any_of()‘ instead.
##   # Was:
##   data %>% select(quant_cols)
##
##   # Now:
##   data %>% select(all_of(quant_cols))
##
## See <https://tidyselect.r-lib.org/reference/faq-external-vector.html>.
```

```
player_combo <- list()
for (year in years) {
  player_combo[[year]] <- merge(merge(agg_data[[year]][[bps[1]]], agg_data[[year]][[bps[2]]], by="Tm", s
}

agg_fa_data <- list()
for (year in years) {
  agg_fa_data[[year]] = fa_data[[year]] %>% group_by(To.Team) %>% summarise(tot_fa_war3=sum(WAR3), num_
}

# add response variable to player data
player_with_wins <- list()
for (year in 1997:2021) {
  player_with_wins[[year]] <- merge(player_combo[[year]], team_wins[[year+1]], by.x="long_Tm.pitch", by
}

player_with_wins_fa <- list()
for (year in 1997:2021) {
  player_with_wins_fa[[year]] <- merge(player_with_wins[[year]], agg_fa_data[[year]], by.x="long_Tm.pit
}


player_with_wins_combined = bind_rows(player_with_wins_fa, )
player_with_wins_combined$W.L..same_year = 100 * player_with_wins_combined$W.L..same_year
player_with_wins_combined$W.L..next_year = 100 * player_with_wins_combined$W.L..next_year

drop_cols = c("long_Tm.pitch", "Rk.bat", "G.bat", "long_Tm.bat", "Rk.pitch", "W", "L", "G.pitch", "long_
              "Age", "GS", "CG", "GS.field", "CG.field", "Rdrs", "Rdrs.yr", "Rgood")
player_with_wins_combined = player_with_wins_combined[, !(names(player_with_wins_combined) %in% drop_col

n.rows = nrow(player_with_wins_combined)
n.train = 0.8 * n.rows
train.rows = sample(n.rows, n.train)
train.df = player_with_wins_combined[train.rows,]
colnames(train.df)[colnames(train.df) == 'OPS.'] <- 'OPSplus'
colnames(train.df)[colnames(train.df) == 'ERA.'] <- 'ERAplus'
test.df = player_with_wins_combined[-train.rows,]
colnames(test.df)[colnames(test.df) == 'OPS.'] <- 'OPSplus'
colnames(test.df)[colnames(test.df) == 'ERA.'] <- 'ERAplus'
```

```r
# train.df
names(train.df)
```

```
##  [1] "Tm"              "Age.bat"         "PA"              "AB"
##  [5] "R.bat"           "H.bat"           "X2B"             "X3B"
##  [9] "HR.bat"          "RBI"             "SB"              "CS"
## [13] "BB.bat"          "SO.bat"          "BA"              "OBP"
## [17] "SLG"             "OPS"             "OPSplus"         "TB"
## [21] "GDP"             "HBP.bat"         "SH"              "SF"
## [25] "IBB.bat"         "year.bat"        "year_adj.bat"    "Age.pitch"
## [29] "W.L..same_year" "ERA"             "GF"              "SHO"
## [33] "SV"              "IP"              "H.pitch"         "R.pitch"
## [37] "ER"              "HR.pitch"        "BB.pitch"        "IBB.pitch"
## [41] "SO.pitch"        "HBP.pitch"       "BK"              "WP"
## [45] "BF"              "ERAplus"         "FIP"             "WHIP"
## [49] "H9"              "HR9"             "BB9"             "SO9"
## [53] "SO.W"            "year.pitch"      "year_adj.pitch" "Rk"
## [57] "G"               "Inn"             "Ch"              "PO"
## [61] "A"               "E"               "DP"              "Fld."
## [65] "Rtot"            "Rtot.yr"         "RF.9"            "RF.G"
## [69] "year"            "year_adj"        "W.L..next_year" "tot_fa_war3"
## [73] "num_fas"
```

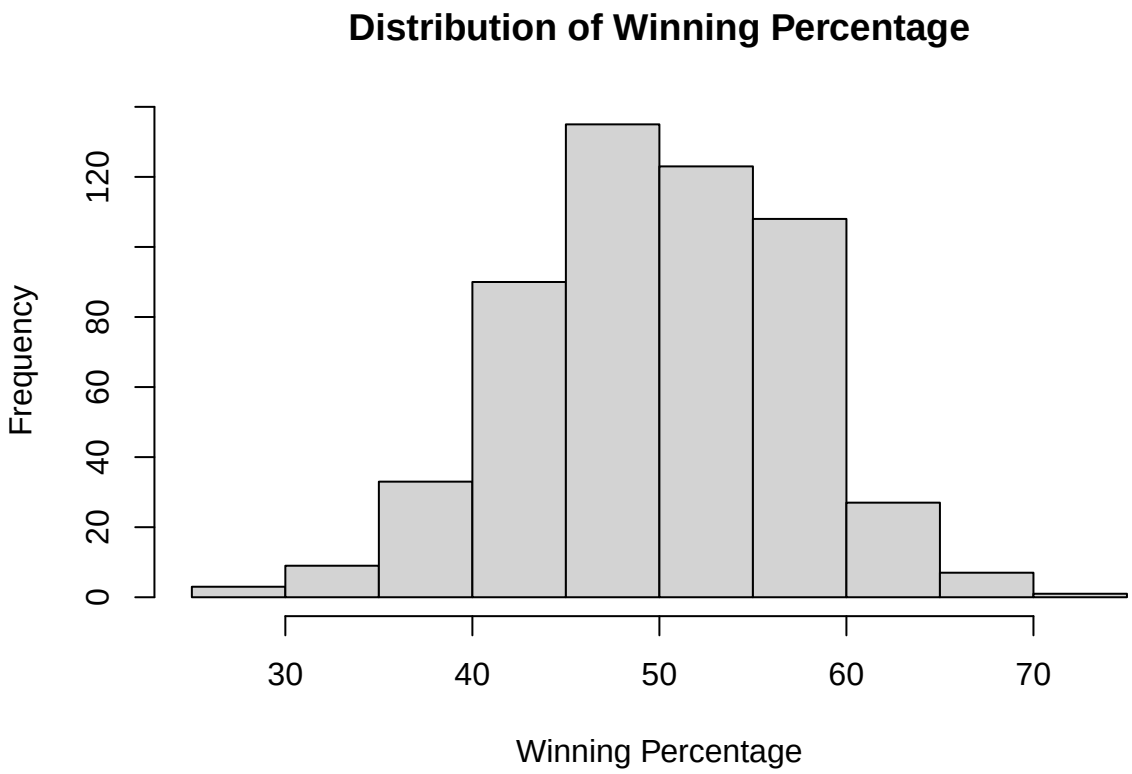
```r
# Explore Potential Predictors
par(mfrow=c(3,4))
plot(W.L..next_year ~ Age.bat, data=train.df,
     xlab="Batters' Avg. Age", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ Age.pitch, data=train.df,
     xlab="Pitchers' Avg. Age", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ BA, data=train.df,
     xlab="Batting Avg.", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ HR.bat, data=train.df,
     xlab="Avg. Home Runs", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ OPSplus, data=train.df,
     xlab="Adjusted OPS", ylab="Winning Percentage", cex=0.3)
plot(W.L..next_year ~ SO.W, data=train.df,
     xlab="Avg. Strikeout/Walk", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ HR9, data=train.df,
     xlab="Avg. HR/9", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ WHIP, data=train.df,
     xlab="WHIP", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ tot_fa_war3, data=train.df,
     xlab="Total Free Agent WAR3", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ E, data=train.df,
     xlab="Errors", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ Fld., data=train.df,
     xlab="Fielding %", ylab="Winning %", cex=0.3)
```




```
# Summary statistics for winpct
summary(train.df$W.L..next_year)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   26.50   44.92   50.00   50.02   55.60   71.60
```

```
# Histogram for winpct
hist(train.df$W.L..next_year, main="Distribution of Winning Percentage",
     xlab="Winning Percentage")
```




```
# Correlation matrix
cor(train.df[, c("W.L..next_year", "Age.bat", "Age.pitch", "BA", "HR.bat", "OPS", "SO.W", "HR9", "WHIP"
```

```
##                 W.L..next_year     Age.bat    Age.pitch          BA      HR.bat
## W.L..next_year     1.00000000  0.10069401  0.259904410  0.09327805  0.23702339
## Age.bat            0.10069401  1.00000000  0.533363355  0.14588484  0.10685172
## Age.pitch          0.25990441  0.53336335  1.000000000  0.10237128  0.17214114
## BA                 0.09327805  0.14588484  0.102371280  1.00000000  0.52898474
## HR.bat             0.23702339  0.10685172  0.172141140  0.52898474  1.00000000
## OPS                0.19061801  0.10878939  0.153635013  0.91397139  0.70368297
## SO.W               0.23998453 -0.11544662  0.009697271 -0.14340068  0.06942594
## HR9               -0.22722895 -0.19005965 -0.127478693  0.06384513  0.12353007
## WHIP              -0.33391466 -0.03728691 -0.105484800  0.18047289 -0.03291794
## tot_fa_war3        0.21653037  0.23692847  0.275825550  0.08333043  0.09643959
## E                  0.04933883  0.05437328  0.068720760  0.17144451  0.25577690
## Fld.               0.07119423  0.15913416  0.188346610  0.03454272  0.10343414
##                          OPS         SO.W         HR9        WHIP tot_fa_war3
## W.L..next_year  0.1906180101  0.239984534 -0.22722895 -0.33391466  0.21653037
## Age.bat         0.1087893917 -0.115446622 -0.19005965 -0.03728691  0.23692847
## Age.pitch       0.1536350127  0.009697271 -0.12747869 -0.10548480  0.27582555
## BA              0.9139713864 -0.143400683  0.06384513  0.18047289  0.08333043
## HR.bat          0.7036829730  0.069425943  0.12353007 -0.03291794  0.09643959
## OPS             1.0000000000 -0.022457204  0.19876634  0.12815999  0.12976917
## SO.W           -0.0224572039  1.000000000 -0.05693183 -0.73539152  0.10459986
## HR9             0.1987663411 -0.056931832  1.00000000  0.43680113 -0.02669281
## WHIP            0.1281599927 -0.735391523  0.43680113  1.00000000 -0.10469556
```

```
## tot_fa_war3     0.1297691667  0.104599862 -0.02669281 -0.10469556  1.00000000
## E               0.0801914975 -0.362533143 -0.16723965  0.23612097 -0.07621814
## Fld.           -0.0006795993  0.018792274 -0.14378095 -0.16724997  0.02502887
##                           E          Fld.
## W.L..next_year  0.04933883  0.0711942298
## Age.bat         0.05437328  0.1591341571
## Age.pitch       0.06872076  0.1883466104
## BA              0.17144451  0.0345427188
## HR.bat          0.25577690  0.1034341438
## OPS             0.08019150 -0.0006795993
## SO.W           -0.36253314  0.0187922740
## HR9            -0.16723965 -0.1437809493
## WHIP            0.23612097 -0.1672499731
## tot_fa_war3    -0.07621814  0.0250288711
## E               1.00000000 -0.0294298787
## Fld.           -0.02942988  1.0000000000
```

```
cor(train.df[, c("W.L..next_year", "Age.bat", "Age.pitch", "BA", "HR.bat", "OPS", "SO.W", "HR9", "WHIP"
```

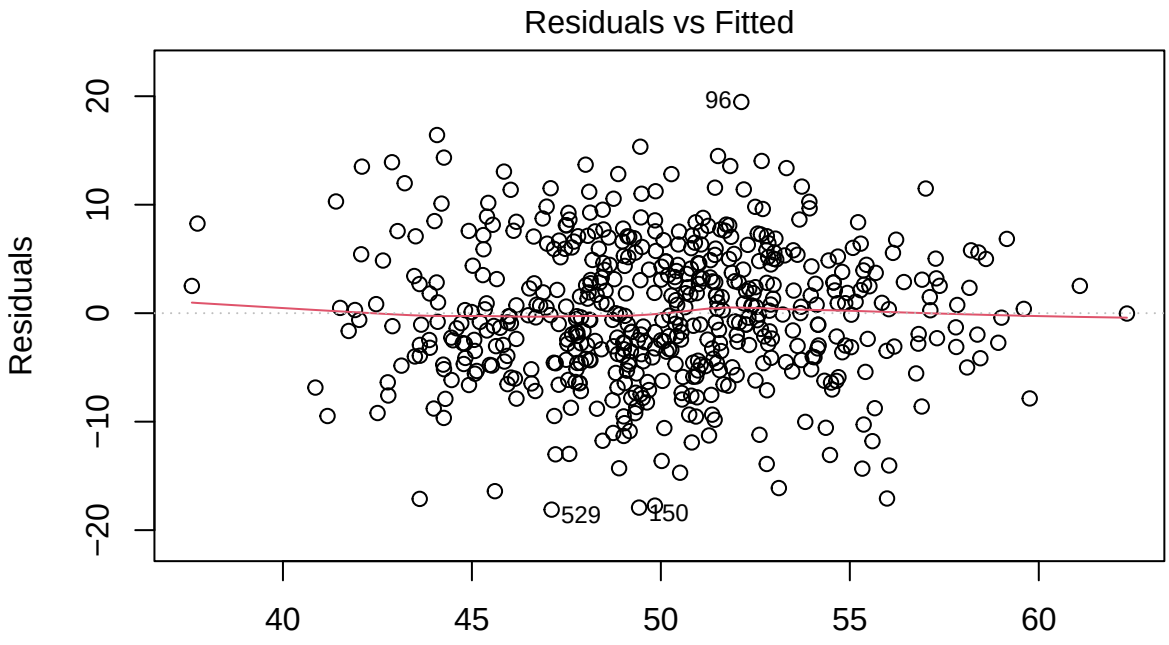
```
##                W.L..next_year     Age.bat    Age.pitch          BA      HR.bat
## W.L..next_year    1.000000000 0.010139283 6.755030e-02 0.008700794 0.056180089
## Age.bat           0.010139283 1.000000000 2.844765e-01 0.021282386 0.011417291
## Age.pitch         0.067550302 0.284476468 1.000000e+00 0.010479879 0.029632572
## BA                0.008700794 0.021282386 1.047988e-02 1.000000000 0.279824858
## HR.bat            0.056180089 0.011417291 2.963257e-02 0.279824858 1.000000000
## OPS               0.036335226 0.011835132 2.360372e-02 0.835343695 0.495169727
## SO.W              0.057592577 0.013327922 9.403707e-05 0.020563756 0.004819962
## HR9               0.051632997 0.036122670 1.625082e-02 0.004076200 0.015259678
## WHIP              0.111498999 0.001390314 1.112704e-02 0.032570463 0.001083591
## tot_fa_war3       0.046885403 0.056135100 7.607973e-02 0.006943960 0.009300595
## E                 0.002434320 0.002956454 4.722543e-03 0.029393219 0.065421824
## Fld.              0.005068618 0.025323680 3.547445e-02 0.001193199 0.010698622
##                         OPS         SO.W          HR9        WHIP  tot_fa_war3
## W.L..next_year 3.633523e-02 5.759258e-02 0.0516329971 0.111498999 0.0468854031
## Age.bat        1.183513e-02 1.332792e-02 0.0361226699 0.001390314 0.0561351002
## Age.pitch      2.360372e-02 9.403707e-05 0.0162508172 0.011127043 0.0760797342
## BA             8.353437e-01 2.056376e-02 0.0040762004 0.032570463 0.0069439600
## HR.bat         4.951697e-01 4.819962e-03 0.0152596784 0.001083591 0.0093005951
## OPS            1.000000e+00 5.043260e-04 0.0395080583 0.016424984 0.0168400366
## SO.W           5.043260e-04 1.000000e+00 0.0032412335 0.540800692 0.0109411311
## HR9            3.950806e-02 3.241234e-03 1.0000000000 0.190795229 0.0007125062
## WHIP           1.642498e-02 5.408007e-01 0.1907952285 1.000000000 0.0109611606
## tot_fa_war3    1.684004e-02 1.094113e-02 0.0007125062 0.010961161 1.0000000000
## E              6.430676e-03 1.314303e-01 0.0279691015 0.055753111 0.0058092054
## Fld.           4.618552e-07 3.531496e-04 0.0206729614 0.027972554 0.0006264444
##                           E          Fld.
## W.L..next_year 0.0024343201 5.068618e-03
## Age.bat        0.0029564538 2.532368e-02
## Age.pitch      0.0047225429 3.547445e-02
## BA             0.0293932191 1.193199e-03
## HR.bat         0.0654218239 1.069862e-02
## OPS            0.0064306763 4.618552e-07
## SO.W           0.1314302800 3.531496e-04
## HR9            0.0279691015 2.067296e-02
```

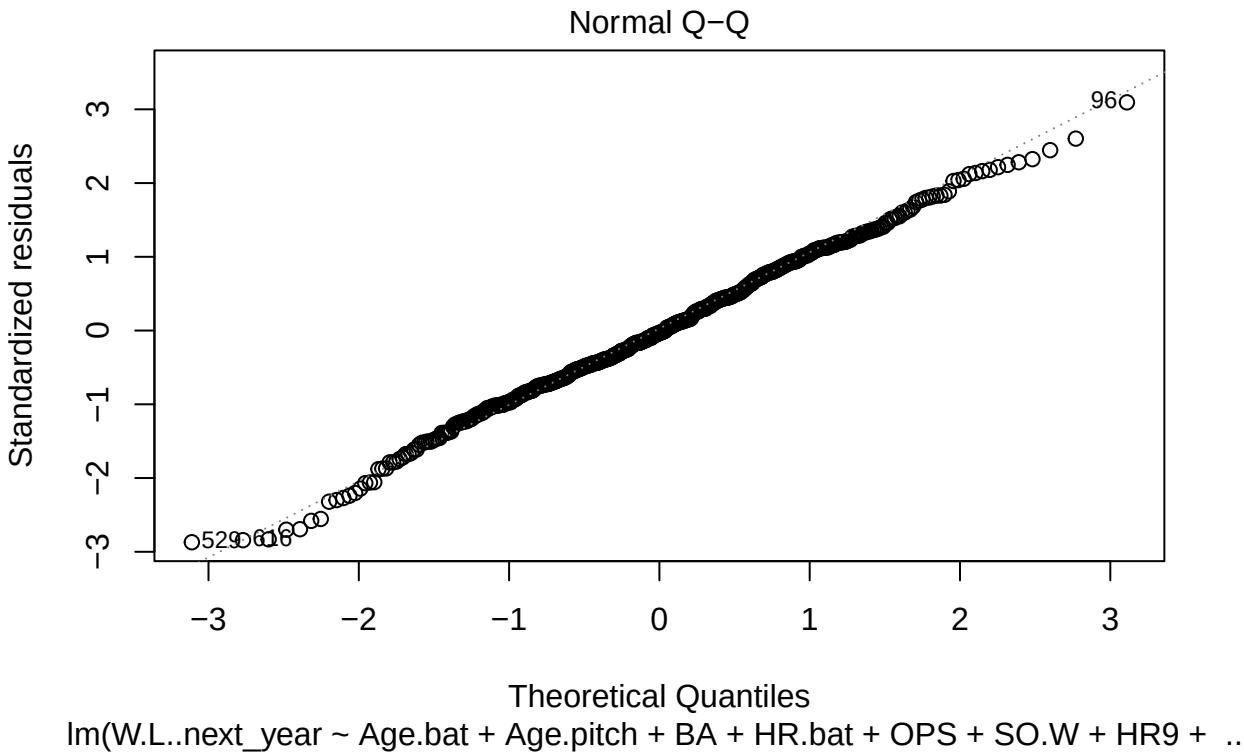
```
## WHIP           0.0557531112 2.797255e-02
## tot_fa_war3    0.0058092054 6.264444e-04
## E              1.0000000000 8.661178e-04
## Fld.           0.0008661178 1.000000e+00
```

```
# Baseline Multiple Regression Model
baseline <- lm(W.L..next_year ~ Age.bat + Age.pitch + BA + HR.bat +
                OPS + SO.W + HR9 + WHIP + tot_fa_war3 + E + Fld. , data = train.df)
summary(baseline)
```

```
##
## Call:
## lm(formula = W.L..next_year ~ Age.bat + Age.pitch + BA + HR.bat +
##     OPS + SO.W + HR9 + WHIP + tot_fa_war3 + E + Fld., data = train.df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -18.1098  -4.2317  -0.2108   4.5912  19.4711
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)   29.95496   40.44845   0.741  0.45929
## Age.bat       -0.29589    0.27350  -1.082  0.27981
## Age.pitch      0.81807    0.27246   3.003  0.00281 **
## BA          -218.32994   44.80108  -4.873 1.46e-06 ***
## HR.bat        -0.14337    0.13947  -1.028  0.30443
## OPS          100.43280   18.24617   5.504 5.81e-08 ***
## SO.W           0.38809    0.82782   0.469  0.63940
## HR9           -7.23683    1.78602  -4.052 5.85e-05 ***
## WHIP         -15.93722    4.93752  -3.228  0.00133 **
## tot_fa_war3    0.07479    0.02492   3.001  0.00282 **
## E              0.83041    0.28691   2.894  0.00396 **
## Fld.          13.79670   39.48353   0.349  0.72691
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 6.386 on 524 degrees of freedom
## Multiple R-squared:  0.2761, Adjusted R-squared:  0.2609
## F-statistic: 18.17 on 11 and 524 DF,  p-value: < 2.2e-16
```

```
# Asssess Linear Model Assumptions
plot(baseline, which=c(1,2))
```


Residuals vs Fitted
Residuals
Fitted values
lm(W.L..next_year ~ Age.bat + Age.pitch + BA + HR.bat + OPS + SO.W + HR9 + ..
96
529
150
20
10
0
−10
−20
40
45
50
55
60




```
RMSE <- function(y,yhat){
  SSE = sum((y-yhat)^2)
  SST = sum((y - mean(y))^2)
  return(sqrt(SSE/length(y)))
}

R2 <- function(y,yhat) {
  SSE = sum((y-yhat)^2)
  SST = sum((y-mean(y))^2)
  r.squared <- 1 - (SSE / SST)
  return(r.squared)
}
baseline.trainRMSE = RMSE(train.df$W.L..next_year, predict(baseline, newdata=train.df))
baseline.testRMSE = RMSE(test.df$W.L..next_year, predict(baseline, newdata=test.df))
baseline.trainR2 = R2(train.df$W.L..next_year, predict(baseline, newdata=train.df))
baseline.testR2 = R2(test.df$W.L..next_year, predict(baseline, newdata=test.df))
```

Linear Regression

```
colnames(train.df)
```

```
##  [1] "Tm"            "Age.bat"       "PA"            "AB"
##  [5] "R.bat"         "H.bat"         "X2B"           "X3B"
```

```
##  [9] "HR.bat"         "RBI"            "SB"             "CS"
## [13] "BB.bat"         "SO.bat"         "BA"             "OBP"
## [17] "SLG"            "OPS"            "OPSplus"        "TB"
## [21] "GDP"            "HBP.bat"        "SH"             "SF"
## [25] "IBB.bat"        "year.bat"       "year_adj.bat"   "Age.pitch"
## [29] "W.L..same_year" "ERA"            "GF"             "SHO"
## [33] "SV"             "IP"             "H.pitch"        "R.pitch"
## [37] "ER"             "HR.pitch"       "BB.pitch"       "IBB.pitch"
## [41] "SO.pitch"       "HBP.pitch"      "BK"             "WP"
## [45] "BF"             "ERAplus"        "FIP"            "WHIP"
## [49] "H9"             "HR9"            "BB9"            "SO9"
## [53] "SO.W"           "year.pitch"     "year_adj.pitch" "Rk"
## [57] "G"              "Inn"            "Ch"             "PO"
## [61] "A"              "E"              "DP"             "Fld."
## [65] "Rtot"           "Rtot.yr"        "RF.9"           "RF.G"
## [69] "year"           "year_adj"       "W.L..next_year" "tot_fa_war3"
## [73] "num_fas"
```

```
# full linear regression models

# ignore Rk.bat, R.bat, RBI, year.bat, year_adj.bat, W, L, R.pitch, year.pitch
# year_adj.pitch, Rk, WL..next_year, year, year_adj, ERA, ERAplus
# Rtot, Rtot.yr, Rdrs, Rgood (hard to interpret)
lm.full <- lm(W.L..next_year ~ Age.bat + PA + AB + H.bat + X2B + X3B +
                HR.bat + SB + CS + BB.bat + SO.bat + BA + OBP + SLG + OPS + OPSplus +
                TB + GDP + HBP.bat + SH + SF + IBB.bat + Age.pitch + W.L..same_year +
                GF + SHO + SV + IP + H.pitch + HR.pitch +
                BB.pitch + IBB.pitch + SO.pitch + HBP.pitch + BK + WP + BF +
                FIP + WHIP + H9 + HR9 + BB9 + SO9 + SO.W +
                G + Inn + Ch + PO + A + E + DP + Fld. +
                RF.9 + RF.G + tot_fa_war3 + num_fas,
              data = train.df)
lmfull.trainRMSE = RMSE(train.df$W.L..next_year, predict(lm.full, newdata=train.df))
```

```
## Warning in predict.lm(lm.full, newdata = train.df): prediction from a rank-
## deficient fit may be misleading
```

```
lmfull.testRMSE = RMSE(test.df$W.L..next_year, predict(lm.full, newdata=test.df))
```

```
## Warning in predict.lm(lm.full, newdata = test.df): prediction from a rank-
## deficient fit may be misleading
```

```
lmfull.trainR2 = R2(train.df$W.L..next_year, predict(lm.full, newdata=train.df))
```

```
## Warning in predict.lm(lm.full, newdata = train.df): prediction from a rank-
## deficient fit may be misleading
```

```
lmfull.testR2 = R2(test.df$W.L..next_year, predict(lm.full, newdata=test.df))
```

```
## Warning in predict.lm(lm.full, newdata = test.df): prediction from a rank-
## deficient fit may be misleading
```

```
lm.fullinteraction <- lm(W.L..next_year ~ (Age.bat + PA + AB + H.bat + X2B + X3B +
                HR.bat + SB + CS + BB.bat + SO.bat + BA + OBP + SLG + OPS + OPSplus +
                TB + GDP + HBP.bat + SH + SF + IBB.bat + Age.pitch + W.L..same_year +
                GF + SHO + SV + IP + H.pitch + HR.pitch +
                BB.pitch + IBB.pitch + SO.pitch + HBP.pitch + BK + WP + BF +
                FIP + WHIP + H9 + HR9 + BB9 + SO9 + SO.W +
                G + Inn + Ch + PO + A + E + DP + Fld. +
                RF.9 + RF.G + tot_fa_war3 + num_fas)^2, data = train.df)
lmfullinteraction.trainRMSE = RMSE(train.df$W.L..next_year, predict(lm.fullinteraction, newdata=train.d
```

```
## Warning in predict.lm(lm.fullinteraction, newdata = train.df): prediction from a
## rank-deficient fit may be misleading
```

```
lmfullinteraction.testRMSE = RMSE(test.df$W.L..next_year, predict(lm.fullinteraction, newdata=test.df))
```

```
## Warning in predict.lm(lm.fullinteraction, newdata = test.df): prediction from a
## rank-deficient fit may be misleading
```

```
lmfullinteraction.trainR2 = R2(train.df$W.L..next_year, predict(lm.fullinteraction, newdata=train.df))
```

```
## Warning in predict.lm(lm.fullinteraction, newdata = train.df): prediction from a
## rank-deficient fit may be misleading
```

```
lmfullinteraction.testR2 = R2(test.df$W.L..next_year, predict(lm.fullinteraction, newdata=test.df))
```

```
## Warning in predict.lm(lm.fullinteraction, newdata = test.df): prediction from a
## rank-deficient fit may be misleading
```

```
# Ridge Regression
set.seed(139)
library(glmnet)
```

```
## Warning: package 'glmnet' was built under R version 4.2.2
```

```
## Loading required package: Matrix
```

```
## Loaded glmnet 4.1-4
```

```
library(caret)
```

```
## Loading required package: ggplot2
```

```
## Loading required package: lattice
```

```
##
## Attaching package: 'caret'
```

```
## The following objects are masked _by_ '.GlobalEnv':
##
##     R2, RMSE
```

```r
# regularize full model
X.full = model.matrix(lm.full)[,-1] # drop intercept
best_lambda = cv.glmnet(X.full, train.df$W.L..next_year, alpha=0, lambda=10^seq(-4, 4, 0.1))$lambda.min
```

```
## [1] 1
```

```r
ridges.full = glmnet(X.full, train.df$W.L..next_year, alpha=0,
                     lambda=best_lambda)
imp <- as.data.frame(varImp(ridges.full, lambda=best_lambda))
imp <- data.frame(overall = imp$Overall,
           names = rownames(imp))
imp[order(imp$overall,decreasing = T),]
```

```
##         overall          names
## 13 4.217839e+01            OBP
## 12 2.274978e+01             BA
## 14 1.078069e+01            SLG
## 15 1.013506e+01            OPS
## 26 6.876722e+00            SHO
## 52 5.783163e+00           Fld.
## 39 4.069115e+00           WHIP
## 35 3.346440e+00             BK
## 41 2.392267e+00            HR9
## 54 2.101617e+00           RF.G
## 6  1.233582e+00            X3B
## 44 9.793445e-01           SO.W
## 40 9.611190e-01             H9
## 1  8.179818e-01        Age.bat
## 23 6.290659e-01      Age.pitch
## 53 6.002864e-01           RF.9
## 38 5.925162e-01            FIP
## 22 5.195899e-01        IBB.bat
## 50 3.976365e-01              E
## 27 3.715344e-01             SV
## 34 3.157535e-01      HBP.pitch
## 7  2.767659e-01         HR.bat
## 30 2.545947e-01       HR.pitch
## 18 2.351641e-01            GDP
## 42 1.947102e-01            BB9
## 20 1.898714e-01             SH
## 43 1.871665e-01            SO9
## 10 1.794350e-01         BB.bat
## 32 1.708381e-01      IBB.pitch
## 25 1.696496e-01             GF
## 56 1.649940e-01        num_fas
## 21 1.600048e-01             SF
## 8  9.664007e-02             SB
## 55 8.648290e-02    tot_fa_war3
## 36 8.577874e-02             WP
## 11 6.865944e-02         SO.bat
## 19 4.933189e-02        HBP.bat
## 16 4.214711e-02        OPSplus
```

```
## 51 3.707557e-02             DP
## 33 3.456779e-02       SO.pitch
## 24 3.399785e-02 W.L..same_year
## 5  3.215792e-02            X2B
## 45 1.830536e-02              G
## 29 1.281783e-02        H.pitch
## 31 1.265390e-02       BB.pitch
## 49 1.197232e-02              A
## 9  1.184976e-02             CS
## 28 1.154114e-02             IP
## 17 9.891688e-03             TB
## 3  9.818909e-03             AB
## 48 8.069036e-03             PO
## 2  5.900980e-03             PA
## 47 3.304332e-03             Ch
## 46 3.221491e-03            Inn
## 4  1.433560e-03          H.bat
## 37 8.980217e-04             BF
```

```
X.full.test = model.matrix(lm.full, data=test.df)[,-1] # drop intercept

yhats.full.train = predict(ridges.full, X.full)
ridgesfull.trainRMSE = RMSE(train.df$W.L..next_year, yhats.full.train) # train RMSE
ridgesfull.trainR2 = R2(train.df$W.L..next_year, yhats.full.train) # train R2

yhats.full.test = predict(ridges.full, X.full.test)
#plot(RMSE.ridges.full.test~log(ridges.full$lambda, 10), type='l')
ridgesfull.testRMSE = RMSE(test.df$W.L..next_year, yhats.full.test) # test RMSE
ridgesfull.testR2 = R2(test.df$W.L..next_year, yhats.full.test) # test R2
```

```
set.seed(139)
# regularize full interaction model
X.fullinteraction = model.matrix(lm.fullinteraction)[,-1] # drop intercept

best_lambda = cv.glmnet(X.fullinteraction, train.df$W.L..next_year, alpha=0,
                        lambda=10^seq(-4, 4, 0.1))$lambda.min; best_lambda
```

```
## [1] 12.58925
```

```
ridges.fullinteraction = glmnet(X.fullinteraction, train.df$W.L..next_year, alpha=0,
                      lambda=best_lambda)
imp <- as.data.frame(varImp(ridges.fullinteraction, lambda=best_lambda))
imp <- data.frame(overall = imp$Overall,
           names = rownames(imp))
imp[order(imp$overall,decreasing = T),]
```

```
##           overall                    names
## 689  3.971714e+00                OBP:Fld.
## 52   3.011010e+00                    Fld.
## 651  2.652964e+00                 OBP:SLG
## 12   2.376880e+00                      BA
## 607  2.254508e+00                  BA:OBP
```

```
## 13   2.211709e+00                  OBP
## 652  1.910242e+00               OBP:OPS
## 1140 1.451282e+00                SHO:BK
## 731  8.042434e-01               SLG:Fld.
## 772  8.008878e-01               OPS:Fld.
## 690  7.571568e-01               OBP:RF.9
## 694  7.538949e-01                SLG:OPS
## 633  7.431867e-01                BA:WHIP
## 663  6.948631e-01                OBP:SHO
## 676  6.926769e-01               OBP:WHIP
## 635  5.757911e-01                 BA:HR9
## 629  5.752399e-01                  BA:BK
## 39   5.552895e-01                   WHIP
## 620  5.038626e-01                BA:SHO
## 691  4.582029e-01               OBP:RF.G
## 609  4.300945e-01                BA:OPS
## 705  4.231354e-01               SLG:SHO
## 646  4.033142e-01               BA:Fld.
## 1456 3.958537e-01              WHIP:Fld.
## 714  3.456103e-01                 SLG:BK
## 1371 2.910512e-01                 BK:HR9
## 679  2.716115e-01               OBP:BB9
## 26   2.657734e-01                    SHO
## 732  2.565773e-01               SLG:RF.9
## 341  2.449990e-01                X3B:SHO
## 54   2.432552e-01                   RF.G
## 608  2.421467e-01                 BA:SLG
## 1588 2.419353e-01              Fld.:RF.G
## 15   2.368416e-01                    OPS
## 746  2.347927e-01               OPS:SHO
## 35   2.072300e-01                     BK
## 773  2.033921e-01               OPS:RF.9
## 675  1.971498e-01                OBP:FIP
## 648  1.899604e-01                BA:RF.G
## 936  1.896294e-01                 SH:SHO
## 1369 1.838728e-01                BK:WHIP
## 672  1.805433e-01                 OBP:BK
## 681  1.805078e-01               OBP:SO.W
## 1157 1.724128e-01               SHO:Fld.
## 1382 1.592275e-01                BK:Fld.
## 671  1.576883e-01           OBP:HBP.pitch
## 67   1.530943e-01              Age.bat:BA
## 755  1.513553e-01                 OPS:BK
## 687  1.469594e-01                  OBP:E
## 658  1.451591e-01                 OBP:SF
## 660  1.435190e-01           OBP:Age.pitch
## 327  1.431498e-01                 X3B:BA
## 720  1.293504e-01               SLG:HR9
## 41   1.292777e-01                   HR9
## 485  1.284087e-01                CS:SHO
## 634  1.275792e-01                 BA:H9
## 664  1.273816e-01                OBP:SV
## 494  1.260141e-01                 CS:BK
## 632  1.243255e-01                BA:FIP
```

```
## 733  1.200543e-01                SLG:RF.G
## 659  1.191406e-01              OBP:IBB.bat
## 657  1.176913e-01                   OBP:SH
## 759  1.164918e-01                 OPS:WHIP
## 673  1.157473e-01                   OBP:WP
## 1144 1.145895e-01                 SHO:WHIP
## 1005 1.127621e-01              IBB.bat:SHO
## 40   1.102220e-01                       H9
## 1458 1.099656e-01              WHIP:RF.G
## 644  1.066233e-01                    BA:E
## 1    1.052906e-01                 Age.bat
## 1487 1.042648e-01                 HR9:Fld.
## 774  1.041291e-01                 OPS:RF.G
## 729  1.037970e-01                    SLG:E
## 1472 1.023144e-01                 H9:Fld.
## 713  9.942192e-02           SLG:HBP.pitch
## 1146 9.898694e-02                 SHO:HR9
## 107  9.643892e-02            Age.bat:Fld.
## 1137 9.465390e-02           SHO:IBB.pitch
## 615  9.382711e-02                   BA:SF
## 616  9.347114e-02              BA:IBB.bat
## 637  9.238713e-02                   BA:SO9
## 701  8.935949e-02              SLG:IBB.bat
## 621  8.864420e-02                   BA:SV
## 23   8.480269e-02              Age.pitch
## 636  8.461930e-02                   BA:BB9
## 680  8.033957e-02                 OBP:SO9
## 1064 7.960332e-02          Age.pitch:Fld.
## 1372 7.905215e-02                   BK:BB9
## 329  7.860658e-02                 X3B:SLG
## 1299 7.804103e-02            IBB.pitch:BK
## 706  7.802904e-02                   SLG:SV
## 700  7.680546e-02                   SLG:SF
## 1344 7.591704e-02            HBP.pitch:BK
## 350  7.556553e-02                   X3B:BK
## 721  7.477139e-02                 SLG:BB9
## 1445 7.443749e-02                WHIP:HR9
## 699  7.417513e-02                   SLG:SH
## 762  7.211343e-02                 OPS:BB9
## 1526 7.035589e-02              SO.W:Fld.
## 656  6.853456e-02              OBP:HBP.bat
## 980  6.786171e-02                    SF:BK
## 677  6.783779e-02                   OBP:H9
## 328  6.596024e-02                 X3B:OBP
## 723  6.520032e-02                SLG:SO.W
## 6    6.449429e-02                     X3B
## 44   6.375426e-02                    SO.W
## 614  6.282467e-02                   BA:SH
## 647  6.038367e-02                 BA:RF.9
## 38   5.993324e-02                     FIP
## 770  5.967080e-02                   OPS:E
## 356  5.953811e-02                 X3B:HR9
## 754  5.810339e-02           OPS:HBP.pitch
## 1141 5.783281e-02                   SHO:WP
```

```
## 1384 5.782399e-02                BK:RF.G
## 628  5.742375e-02             BA:HBP.pitch
## 900  5.713535e-02              HBP.bat:SHO
## 1366 5.617593e-02                    BK:WP
## 1368 5.439950e-02                   BK:FIP
## 447  5.273457e-02                    SB:BK
## 702  5.186265e-02            SLG:Age.pitch
## 1159 5.158131e-02                 SHO:RF.G
## 617  5.118097e-02             BA:Age.pitch
## 669  5.106289e-02            OBP:IBB.pitch
## 638  5.080096e-02                  BA:SO.W
## 915  5.039940e-02              HBP.bat:HR9
## 986  5.038346e-02                   SF:HR9
## 761  4.988229e-02                  OPS:HR9
## 69   4.962769e-02              Age.bat:SLG
## 1160 4.918843e-02          SHO:tot_fa_war3
## 367  4.880203e-02                 X3B:Fld.
## 718  4.878327e-02                 SLG:WHIP
## 742  4.789148e-02              OPS:IBB.bat
## 711  4.786895e-02            SLG:IBB.pitch
## 741  4.774422e-02                   OPS:SF
## 909  4.710678e-02               HBP.bat:BK
## 758  4.699691e-02                  OPS:FIP
## 1489 4.695192e-02                 HR9:RF.G
## 717  4.675076e-02                  SLG:FIP
## 764  4.646840e-02                  OPS:SO.W
## 1155 4.628319e-02                     SHO:E
## 1158 4.605704e-02                 SHO:RF.9
## 747  4.569566e-02                    OPS:SV
## 1383 4.510770e-02                  BK:RF.9
## 740  4.442246e-02                    OPS:SH
## 472  4.326679e-02                    CS:OBP
## 715  4.152975e-02                    SLG:WP
## 68   4.080505e-02              Age.bat:OBP
## 743  3.958769e-02            OPS:Age.pitch
## 1493 3.860254e-02                 BB9:SO.W
## 438  3.854254e-02                    SB:SHO
## 330  3.804060e-02                   X3B:OPS
## 1143 3.604801e-02                  SHO:FIP
## 655  3.427950e-02                  OBP:GDP
## 1457 3.393667e-02                WHIP:RF.9
## 1014 3.379623e-02               IBB.bat:BK
## 94   3.365095e-02             Age.bat:WHIP
## 377  3.317381e-02               HR.bat:OBP
## 630  3.315595e-02                    BA:WP
## 14   3.279488e-02                      SLG
## 1169 3.225975e-02                    SV:BK
## 667  3.183930e-02             OBP:HR.pitch
## 1373 3.083093e-02                   BK:SO9
## 756  3.063245e-02                  OPS:WP
## 1447 2.955980e-02                 WHIP:SO9
## 349  2.832054e-02            X3B:HBP.pitch
## 1132 2.822281e-02                   SHO:SV
## 1149 2.804979e-02                 SHO:SO.W
```

```
## 354  2.779925e-02                X3B:WHIP
## 954  2.711999e-02                 SH:SO.W
## 70   2.702476e-02              Age.bat:OPS
## 1591 2.668484e-02                RF.9:RF.G
## 662  2.664128e-02                   OBP:GF
## 1370 2.631823e-02                    BK:H9
## 1514 2.612562e-02                  SO9:Fld.
## 698  2.601975e-02              SLG:HBP.bat
## 359  2.584406e-02                 X3B:SO.W
## 1477 2.577405e-02                  HR9:BB9
## 27   2.469946e-02                       SV
## 752  2.436719e-02            OPS:IBB.pitch
## 376  2.412066e-02                HR.bat:BA
## 518  2.408625e-02              BB.bat:OBP
## 1361 2.382748e-02           HBP.pitch:Fld.
## 1145 2.323158e-02                  SHO:H9
## 1175 2.287538e-02                  SV:HR9
## 517  2.274810e-02                BB.bat:BA
## 425  2.267790e-02                   SB:OBP
## 1116 2.230366e-02                  GF:HR9
## 977  2.207800e-02             SF:IBB.pitch
## 1474 2.199031e-02                  H9:RF.G
## 1161 2.195332e-02              SHO:num_fas
## 503  2.124997e-02                  CS:SO.W
## 1503 2.103081e-02                 BB9:RF.G
## 945  2.041192e-02                    SH:BK
## 1479 2.033296e-02                 HR9:SO.W
## 688  2.001440e-02                   OBP:DP
## 1444 1.958534e-02                  WHIP:H9
## 739  1.894098e-02              OPS:HBP.bat
## 43   1.892960e-02                      SO9
## 1524 1.889001e-02                   SO.W:E
## 1135 1.853611e-02             SHO:HR.pitch
## 500  1.816106e-02                   CS:HR9
## 1101 1.815144e-02                   GF:SHO
## 913  1.799634e-02             HBP.bat:WHIP
## 1446 1.796278e-02                 WHIP:BB9
## 378  1.767225e-02                HR.bat:SLG
## 668  1.736122e-02             OBP:BB.pitch
## 1147 1.721722e-02                  SHO:BB9
## 1127 1.655297e-02                  GF:Fld.
## 416  1.630558e-02                HR.bat:Fld.
## 22   1.606326e-02                   IBB.bat
## 649  1.580185e-02           BA:tot_fa_war3
## 32   1.555197e-02                 IBB.pitch
## 519  1.553815e-02                BB.bat:SLG
## 730  1.528990e-02                   SLG:DP
## 109  1.521821e-02             Age.bat:RF.G
## 42   1.470041e-02                      BB9
## 1527 1.467990e-02                 SO.W:RF.9
## 650  1.435896e-02                BA:num_fas
## 1386 1.432088e-02                BK:num_fas
## 709  1.412014e-02             SLG:HR.pitch
## 1256 1.410534e-02             HR.pitch:HR9
```

```
## 1391 1.388774e-02                  WP:HR9
## 682  1.383183e-02                   OBP:G
## 1250 1.380008e-02              HR.pitch:BK
## 1114 1.356985e-02                  GF:WHIP
## 20   1.327463e-02                       SH
## 661  1.318720e-02       OBP:W.L..same_year
## 692  1.313637e-02          OBP:tot_fa_war3
## 1461 1.307011e-02                  H9:HR9
## 931  1.289247e-02                   SH:SF
## 670  1.284509e-02             OBP:SO.pitch
## 878  1.269036e-02                  GDP:HR9
## 471  1.266500e-02                   CS:BA
## 18   1.263059e-02                     GDP
## 619  1.257436e-02                   BA:GF
## 1385 1.244539e-02           BK:tot_fa_war3
## 335  1.222442e-02                  X3B:SH
## 347  1.221575e-02            X3B:IBB.pitch
## 1298 1.211775e-02       IBB.pitch:HBP.pitch
## 369  1.209245e-02                 X3B:RF.G
## 1139 1.205608e-02            SHO:HBP.pitch
## 1110 1.192761e-02                   GF:BK
## 21   1.181365e-02                      SF
## 379  1.172654e-02               HR.bat:OPS
## 863  1.169686e-02                  GDP:SHO
## 9    1.165614e-02                       CS
## 334  1.160934e-02               X3B:HBP.bat
## 424  1.160179e-02                   SB:BA
## 1394 1.156067e-02                  WP:SO.W
## 1428 1.155146e-02                  FIP:HR9
## 1441 1.151237e-02                FIP:RF.G
## 336  1.146619e-02                  X3B:SF
## 1485 1.136025e-02                   HR9:E
## 1528 1.128986e-02               SO.W:RF.G
## 1156 1.127650e-02                  SHO:DP
## 896  1.125495e-02           HBP.bat:IBB.bat
## 1473 1.117145e-02                  H9:RF.9
## 557  1.102507e-02              BB.bat:Fld.
## 278  1.099899e-02                  X2B:OBP
## 1305 1.079650e-02            IBB.pitch:HR9
## 7    1.074869e-02                   HR.bat
## 1488 1.066378e-02                 HR9:RF.9
## 357  1.056395e-02                  X3B:BB9
## 353  1.044802e-02                  X3B:FIP
## 1353 1.031960e-02            HBP.pitch:SO.W
## 951  1.028043e-02                   SH:HR9
## 368  1.012502e-02                 X3B:RF.9
## 50   1.007517e-02                        E
## 96   1.004820e-02               Age.bat:HR9
## 90   1.000409e-02                Age.bat:BK
## 697  9.993154e-03                   SLG:GDP
## 358  9.992964e-03                  X3B:SO9
## 324  9.943680e-03                   X3B:CS
## 734  9.853330e-03           SLG:tot_fa_war3
## 665  9.805281e-03                   OBP:IP
```

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## 1426 9.803660e-03                FIP:WHIP
## 30   9.536256e-03                HR.pitch
## 520  9.424144e-03               BB.bat:OPS
## 613  9.332153e-03               BA:HBP.bat
## 1148 9.092927e-03                  SHO:SO9
## 750  9.089627e-03              OPS:HR.pitch
## 1267 9.078266e-03             HR.pitch:Fld.
## 1031 9.031040e-03              IBB.bat:Fld.
## 942  8.948766e-03              SH:IBB.pitch
## 1254 8.941889e-03             HR.pitch:WHIP
## 962  8.941043e-03                   SH:Fld.
## 678  8.871109e-03                   OBP:HR9
## 686  8.809395e-03                     OBP:A
## 704  8.696330e-03                    SLG:GF
## 719  8.628323e-03                    SLG:H9
## 1020 8.508976e-03              IBB.bat:HR9
## 1402 8.457408e-03                   WP:Fld.
## 108  8.420836e-03              Age.bat:RF.9
## 940  8.363055e-03              SH:HR.pitch
## 474  8.336412e-03                   CS:OPS
## 25   8.317383e-03                       GF
## 1023 8.282609e-03              IBB.bat:SO.W
## 771  8.279401e-03                   OPS:DP
## 738  7.985627e-03                  OPS:GDP
## 645  7.960917e-03                    BA:DP
## 953  7.959440e-03                   SH:SO9
## 403  7.757206e-03               HR.bat:WHIP
## 396  7.748823e-03          HR.bat:IBB.pitch
## 932  7.741391e-03               SH:IBB.bat
## 1348 7.737803e-03            HBP.pitch:WHIP
## 1186 7.707056e-03                   SV:Fld.
## 724  7.629847e-03                     SLG:G
## 10   7.596690e-03                    BB.bat
## 291  7.573368e-03                   X2B:SHO
## 624  7.488746e-03               BA:HR.pitch
## 426  7.387462e-03                    SB:SLG
## 1065 7.365444e-03            Age.pitch:RF.9
## 1478 7.342171e-03                   HR9:SO9
## 493  7.338263e-03             CS:HBP.pitch
## 639  7.320032e-03                     BA:G
## 562  7.309118e-03                SO.bat:BA
## 763  7.279502e-03                   OPS:SO9
## 408  7.213599e-03               HR.bat:SO.W
## 1400 7.207647e-03                     WP:E
## 511  7.128310e-03                   CS:Fld.
## 710  7.115395e-03             SLG:BB.pitch
## 1577 7.112279e-03                    E:Fld.
## 1440 7.080357e-03                  FIP:RF.9
## 498  7.047090e-03                   CS:WHIP
## 918  7.014999e-03              HBP.bat:SO.W
## 1275 6.954252e-03               BB.pitch:BK
## 912  6.933986e-03               HBP.bat:FIP
## 1439 6.855451e-03                  FIP:Fld.
## 1506 6.854900e-03                  SO9:SO.W
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## 1051 6.844254e-03            Age.pitch:WHIP
## 964  6.799324e-03                   SH:RF.G
## 427  6.776490e-03                    SB:OPS
## 728  6.565328e-03                     SLG:A
## 540  6.544980e-03                 BB.bat:BK
## 317  6.482440e-03                  X2B:Fld.
## 1303 6.467133e-03            IBB.pitch:WHIP
## 1403 6.410927e-03                   WP:RF.9
## 1351 6.406434e-03             HBP.pitch:BB9
## 544  6.343418e-03               BB.bat:WHIP
## 745  6.274505e-03                    OPS:GF
## 1362 6.222346e-03            HBP.pitch:RF.9
## 1463 6.203770e-03                    H9:SO9
## 1176 6.164275e-03                    SV:BB9
## 906  6.109253e-03         HBP.bat:IBB.pitch
## 464  5.971796e-03                  SB:Fld.
## 95   5.969222e-03                Age.bat:H9
## 300  5.831623e-03                    X2B:BK
## 889  5.702026e-03                 GDP:Fld.
## 666  5.669759e-03               OBP:H.pitch
## 643  5.644944e-03                     BA:A
## 1318 5.628660e-03            IBB.pitch:RF.G
## 1380 5.578070e-03                     BK:E
## 93   5.538445e-03               Age.bat:FIP
## 1170 5.528560e-03                    SV:WP
## 901  5.526319e-03               HBP.bat:SV
## 722  5.458975e-03                  SLG:SO9
## 707  5.425035e-03                   SLG:IP
## 760  5.412739e-03                   OPS:H9
## 949  5.410253e-03                  SH:WHIP
## 1047 5.377120e-03              Age.pitch:BK
## 1129 5.374662e-03                   GF:RF.G
## 1316 5.372418e-03            IBB.pitch:Fld.
## 775  5.371003e-03           OPS:tot_fa_war3
## 627  5.241618e-03               BA:SO.pitch
## 1136 5.169079e-03              SHO:BB.pitch
## 751  5.087064e-03              OPS:BB.pitch
## 1462 5.057751e-03                    H9:BB9
## 916  5.048370e-03               HBP.bat:BB9
## 1460 5.039952e-03              WHIP:num_fas
## 869  5.009101e-03             GDP:IBB.pitch
## 989  4.989451e-03                   SF:SO.W
## 1038 4.972094e-03             Age.pitch:SHO
## 881  4.967240e-03                  GDP:SO.W
## 418  4.922838e-03               HR.bat:RF.G
## 1430 4.861545e-03                   FIP:SO9
## 610  4.854555e-03               BA:OPSplus
## 56   4.839495e-03                  num_fas
## 712  4.803343e-03              SLG:SO.pitch
## 983  4.790839e-03                    SF:FIP
## 34   4.779285e-03                HBP.pitch
## 765  4.776612e-03                     OPS:G
## 417  4.758738e-03               HR.bat:RF.9
## 1281 4.693298e-03              BB.pitch:HR9
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## 948  4.644297e-03                  SH:FIP
## 876  4.617442e-03                GDP:WHIP
## 1515 4.593939e-03                SO9:RF.9
## 981  4.585979e-03                   SF:WP
## 1404 4.569727e-03                 WP:RF.G
## 1590 4.536445e-03             Fld.:num_fas
## 654  4.491905e-03                  OBP:TB
## 937  4.478865e-03                   SH:SV
## 1512 4.475191e-03                   SO9:E
## 1589 4.473139e-03         Fld.:tot_fa_war3
## 53   4.470008e-03                    RF.9
## 1374 4.440815e-03                 BK:SO.W
## 456  4.423764e-03                 SB:SO.W
## 987  4.398587e-03                  SF:BB9
## 491  4.384831e-03             CS:IBB.pitch
## 1431 4.380043e-03                 FIP:SO.W
## 55   4.293865e-03              tot_fa_war3
## 998  4.280652e-03                  SF:RF.9
## 306  4.222972e-03                  X2B:HR9
## 546  4.222697e-03                BB.bat:HR9
## 355  4.212007e-03                   X3B:H9
## 1314 4.196096e-03              IBB.pitch:E
## 309  4.165932e-03                 X2B:SO.W
## 434  4.103436e-03                SB:IBB.bat
## 1113 4.051465e-03                   GF:FIP
## 944  4.025964e-03             SH:HBP.pitch
## 622  4.016616e-03                    BA:IP
## 453  4.012801e-03                  SB:HR9
## 1345 3.940822e-03             HBP.pitch:WP
## 1178 3.913898e-03                  SV:SO.W
## 1491 3.875607e-03              HR9:num_fas
## 1347 3.836093e-03            HBP.pitch:FIP
## 1308 3.785456e-03           IBB.pitch:SO.W
## 495  3.687057e-03                    CS:WP
## 965  3.668083e-03            SH:tot_fa_war3
## 576  3.661539e-03                SO.bat:SHO
## 769  3.654088e-03                     OPS:A
## 1490 3.621914e-03           HR9:tot_fa_war3
## 61   3.610250e-03               Age.bat:X3B
## 786  3.572970e-03               OPSplus:SHO
## 24   3.563137e-03            W.L..same_year
## 16   3.525394e-03                   OPSplus
## 1011 3.518253e-03         IBB.bat:IBB.pitch
## 1306 3.486183e-03             IBB.pitch:BB9
## 753  3.481815e-03              OPS:SO.pitch
## 946  3.479679e-03                    SH:WP
## 549  3.458459e-03              BB.bat:SO.W
## 1054 3.451387e-03             Age.pitch:BB9
## 1406 3.436279e-03                WP:num_fas
## 748  3.312355e-03                   OPS:IP
## 81   3.311474e-03              Age.bat:SHO
## 406  3.270010e-03              HR.bat:BB9
## 36   3.238175e-03                       WP
## 1166 3.238027e-03              SV:IBB.pitch
```

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## 1579 3.203783e-03                  E:RF.G
## 591  3.197874e-03                SO.bat:HR9
## 1117 3.103039e-03                    GF:BB9
## 1133 3.102075e-03                    SHO:IP
## 1138 3.090959e-03               SHO:SO.pitch
## 914  3.077739e-03                 HBP.bat:H9
## 1582 3.070155e-03                   DP:Fld.
## 398  3.061915e-03           HR.bat:HBP.pitch
## 439  3.008918e-03                     SB:SV
## 1134 3.008077e-03                SHO:H.pitch
## 1505 3.005610e-03                BB9:num_fas
## 1258 3.003244e-03               HR.pitch:SO9
## 1168 2.985217e-03               SV:HBP.pitch
## 971  2.962798e-03                    SF:SHO
## 910  2.937620e-03                 HBP.bat:WP
## 984  2.927051e-03                    SF:WHIP
## 559  2.921895e-03                BB.bat:RF.G
## 1317 2.915008e-03             IBB.pitch:RF.9
## 1111 2.914575e-03                     GF:WP
## 703  2.908307e-03         SLG:W.L..same_year
## 1079 2.898715e-03          W.L..same_year:BK
## 1187 2.891365e-03                  SV:RF.9
## 1128 2.890820e-03                  GF:RF.9
## 558  2.878315e-03                BB.bat:RF.9
## 97   2.869755e-03                Age.bat:BB9
## 479  2.855572e-03                     CS:SH
## 708  2.855055e-03                SLG:H.pitch
## 1595 2.854369e-03               RF.G:num_fas
## 1203 2.817631e-03                    IP:HR9
## 547  2.812861e-03                 BB.bat:BB9
## 611  2.793695e-03                     BA:TB
## 11   2.784093e-03                   SO.bat
## 1119 2.783439e-03                  GF:SO.W
## 226  2.760193e-03                 H.bat:BA
## 618  2.749764e-03          BA:W.L..same_year
## 33   2.748930e-03                  SO.pitch
## 1032 2.715406e-03               IBB.bat:RF.9
## 501  2.714089e-03                    CS:BB9
## 1230 2.703886e-03                H.pitch:HR9
## 280  2.695484e-03                    X2B:OPS
## 1050 2.666785e-03              Age.pitch:FIP
## 297  2.649352e-03              X2B:IBB.pitch
## 589  2.646417e-03                SO.bat:WHIP
## 904  2.645772e-03           HBP.bat:HR.pitch
## 462  2.629869e-03                     SB:E
## 1257 2.625926e-03               HR.pitch:BB9
## 1427 2.618363e-03                    FIP:H9
## 1253 2.611880e-03               HR.pitch:FIP
## 1241 2.598600e-03               H.pitch:Fld.
## 744  2.593944e-03         OPS:W.L..same_year
## 1529 2.523966e-03           SO.W:tot_fa_war3
## 696  2.509044e-03                  SLG:TB
## 390  2.444002e-03                HR.bat:SHO
## 5    2.427284e-03                     X2B
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## 497  2.413191e-03                  CS:FIP
## 478  2.411047e-03               CS:HBP.bat
## 279  2.404593e-03                  X2B:SLG
## 564  2.401802e-03               SO.bat:SLG
## 988  2.399766e-03                   SF:SO9
## 1454 2.390003e-03                  WHIP:E
## 1259 2.386285e-03             HR.pitch:SO.W
## 1516 2.367026e-03                  SO9:RF.G
## 1459 2.337381e-03          WHIP:tot_fa_war3
## 1115 2.332811e-03                    GF:H9
## 1018 2.329919e-03             IBB.bat:WHIP
## 512  2.321729e-03                  CS:RF.9
## 1448 2.319541e-03               WHIP:SO.W
## 935  2.318686e-03                   SH:GF
## 391  2.314370e-03               HR.bat:SV
## 502  2.314165e-03                  CS:SO9
## 1118 2.285668e-03                  GF:SO9
## 1224 2.256394e-03               H.pitch:BK
## 51   2.245358e-03                      DP
## 19   2.212213e-03                 HBP.bat
## 481  2.211505e-03               CS:IBB.bat
## 858  2.207255e-03                   GDP:SF
## 1302 2.175541e-03            IBB.pitch:FIP
## 1083 2.174194e-03       W.L..same_year:WHIP
## 480  2.160866e-03                   CS:SF
## 894  2.143768e-03               HBP.bat:SH
## 1364 2.143213e-03     HBP.pitch:tot_fa_war3
## 1328 2.142184e-03            SO.pitch:HR9
## 342  2.141680e-03                  X3B:SV
## 373  2.119261e-03               HR.bat:CS
## 386  2.117362e-03            HR.bat:IBB.bat
## 812  2.109453e-03              OPSplus:Fld.
## 891  2.082132e-03                  GDP:RF.G
## 975  2.080938e-03               SF:HR.pitch
## 924  2.065298e-03                 HBP.bat:E
## 1339 2.053444e-03             SO.pitch:Fld.
## 531  2.034900e-03                BB.bat:SHO
## 318  2.032840e-03                  X2B:RF.9
## 1359 2.031213e-03               HBP.pitch:E
## 414  2.017111e-03                  HR.bat:E
## 674  1.972847e-03                   OBP:BF
## 875  1.971206e-03                  GDP:FIP
## 451  1.969896e-03                   SB:WHIP
## 1013 1.926518e-03         IBB.bat:HBP.pitch
## 928  1.919216e-03              HBP.bat:RF.G
## 1056 1.913736e-03            Age.pitch:SO.W
## 407  1.892571e-03               HR.bat:SO9
## 1096 1.860992e-03       W.L..same_year:Fld.
## 602  1.854118e-03               SO.bat:Fld.
## 1437 1.842555e-03                   FIP:E
## 1300 1.820002e-03             IBB.pitch:WP
## 930  1.819938e-03           HBP.bat:num_fas
## 1109 1.815741e-03              GF:HBP.pitch
## 1486 1.789378e-03                   HR9:DP
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## 319  1.788738e-03                 X2B:RF.G
## 749  1.788614e-03              OPS:H.pitch
## 1363 1.781543e-03           HBP.pitch:RF.G
## 421  1.760059e-03                    SB:CS
## 399  1.753076e-03                HR.bat:BK
## 872  1.752876e-03                   GDP:BK
## 1388 1.748555e-03                   WP:FIP
## 465  1.747314e-03                  SB:RF.9
## 1034 1.745186e-03       IBB.bat:tot_fa_war3
## 1173 1.732868e-03                  SV:WHIP
## 1228 1.731639e-03             H.pitch:WHIP
## 1066 1.731320e-03           Age.pitch:RF.G
## 966  1.723853e-03               SH:num_fas
## 683  1.711187e-03                  OBP:Inn
## 174  1.705188e-03                    AB:BA
## 684  1.703822e-03                   OBP:Ch
## 402  1.700583e-03                HR.bat:FIP
## 1587 1.699914e-03                 Fld.:RF.9
## 1006 1.683692e-03                IBB.bat:SV
## 1009 1.681006e-03          IBB.bat:HR.pitch
## 799  1.678546e-03              OPSplus:WHIP
## 1022 1.677731e-03                IBB.bat:SO9
## 960  1.664422e-03                      SH:E
## 895  1.658631e-03                HBP.bat:SF
## 1214 1.657686e-03                   IP:Fld.
## 543  1.656883e-03                BB.bat:FIP
## 537  1.653650e-03          BB.bat:IBB.pitch
## 340  1.605239e-03                   X3B:GF
## 548  1.602584e-03                BB.bat:SO9
## 1584 1.602278e-03                   DP:RF.G
## 1405 1.597605e-03           WP:tot_fa_war3
## 31   1.561608e-03                 BB.pitch
## 801  1.560053e-03               OPSplus:HR9
## 45   1.559683e-03                         G
## 525  1.549034e-03                BB.bat:SH
## 1464 1.536271e-03                   H9:SO.W
## 851  1.531104e-03                   TB:Fld.
## 737  1.530703e-03                    OPS:TB
## 1154 1.512489e-03                    SHO:A
## 541  1.507308e-03                BB.bat:WP
## 685  1.483560e-03                   OBP:PO
## 1499 1.478929e-03                    BB9:E
## 1085 1.463027e-03        W.L..same_year:HR9
## 29   1.455263e-03                 H.pitch
## 563  1.443899e-03                SO.bat:OBP
## 121  1.427913e-03                     PA:BA
## 1150 1.426900e-03                    SHO:G
## 985  1.425264e-03                    SF:H9
## 963  1.420810e-03                  SH:RF.9
## 400  1.418797e-03                HR.bat:WP
## 489  1.414720e-03               CS:HR.pitch
## 995  1.412228e-03                      SF:E
## 893  1.407727e-03              GDP:num_fas
## 1247 1.404905e-03        HR.pitch:IBB.pitch
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## 1501 1.401260e-03                  BB9:Fld.
## 857  1.395703e-03                    GDP:SH
## 466  1.393432e-03                   SB:RF.G
## 795  1.391322e-03                 OPSplus:BK
## 1401 1.389023e-03                      WP:DP
## 1174 1.388546e-03                      SV:H9
## 1255 1.385150e-03                HR.pitch:H9
## 539  1.381871e-03           BB.bat:HBP.pitch
## 1322 1.380335e-03                SO.pitch:BK
## 514  1.373476e-03             CS:tot_fa_war3
## 384  1.367496e-03                  HR.bat:SH
## 929  1.365240e-03         HBP.bat:tot_fa_war3
## 1201 1.360004e-03                 IP:WHIP
## 240  1.359953e-03                H.bat:SHO
## 292  1.354144e-03                   X2B:SV
## 1197 1.351600e-03                    IP:BK
## 926  1.348930e-03              HBP.bat:Fld.
## 1086 1.344476e-03          W.L..same_year:BB9
## 1593 1.339754e-03              RF.9:num_fas
## 1029 1.330411e-03                 IBB.bat:E
## 91   1.322872e-03                Age.bat:WP
## 972  1.314147e-03                     SF:SV
## 1177 1.294042e-03                   SV:SO9
## 339  1.282402e-03          X3B:W.L..same_year
## 64   1.257696e-03                 Age.bat:CS
## 255  1.233608e-03                  H.bat:HR9
## 1518 1.229796e-03                SO9:num_fas
## 1393 1.228307e-03                     WP:SO9
## 454  1.184296e-03                     SB:BB9
## 1268 1.184293e-03               HR.pitch:RF.9
## 228  1.161068e-03                   H.bat:SLG
## 1279 1.159169e-03               BB.pitch:WHIP
## 1265 1.157116e-03                  HR.pitch:E
## 1055 1.154230e-03               Age.pitch:SO9
## 941  1.152612e-03                 SH:BB.pitch
## 1592 1.144772e-03            RF.9:tot_fa_war3
## 999  1.136547e-03                     SF:RF.G
## 1021 1.124784e-03                  IBB.bat:BB9
## 404  1.106523e-03                    HR.bat:H9
## 1107 1.105758e-03                GF:IBB.pitch
## 565  1.105315e-03                  SO.bat:OPS
## 1307 1.080626e-03               IBB.pitch:SO9
## 532  1.076476e-03                   BB.bat:SV
## 1502 1.075975e-03                   BB9:RF.9
## 834  1.075237e-03                      TB:BK
## 1480 1.069009e-03                     HR9:G
## 455  1.068257e-03                     SB:SO9
## 405  1.060855e-03                  HR.bat:HR9
## 1594 1.059212e-03            RF.G:tot_fa_war3
## 499  1.057858e-03                     CS:H9
## 640  1.047346e-03                    BA:Inn
## 1015 1.046096e-03                  IBB.bat:WP
## 509  1.042791e-03                       CS:E
## 73   1.040762e-03                 Age.bat:GDP
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## 1581 1.040413e-03                E:num_fas
## 473  1.036198e-03                   CS:SLG
## 555  1.019626e-03                 BB.bat:E
## 950  1.019331e-03                    SH:H9
## 1125 1.013187e-03                     GF:E
## 725  1.008726e-03                   SLG:Inn
## 1184 1.008577e-03                     SV:E
## 308  1.001645e-03                  X2B:SO9
## 1033 1.000573e-03              IBB.bat:RF.G
## 333  9.969410e-04                   X3B:GDP
## 385  9.968927e-04                HR.bat:SF
## 716  9.902044e-04                   SLG:BF
## 877  9.832928e-04                   GDP:H9
## 351  9.775333e-04                   X3B:WP
## 873  9.754506e-04                   GDP:WP
## 880  9.641139e-04                  GDP:SO9
## 323  9.604492e-04                   X3B:SB
## 370  9.587238e-04           X3B:tot_fa_war3
## 1315 9.551506e-04              IBB.pitch:DP
## 85   9.500218e-04          Age.bat:HR.pitch
## 1379 9.471108e-04                      BK:A
## 588  9.466710e-04                SO.bat:FIP
## 726  9.453582e-04                   SLG:Ch
## 1583 9.362743e-04                  DP:RF.9
## 338  9.360254e-04             X3B:Age.pitch
## 345  9.281482e-04              X3B:HR.pitch
## 653  9.207655e-04               OBP:OPSplus
## 515  9.186500e-04                CS:num_fas
## 75   9.027275e-04                Age.bat:SH
## 933  8.921443e-04              SH:Age.pitch
## 366  8.780843e-04                     X3B:DP
## 967  8.671729e-04                SF:IBB.bat
## 545  8.650487e-04                 BB.bat:H9
## 382  8.619608e-04                HR.bat:GDP
## 1046 8.571312e-04        Age.pitch:HBP.pitch
## 1062 8.562230e-04                Age.pitch:E
## 1504 8.359827e-04           BB9:tot_fa_war3
## 1030 8.357146e-04                IBB.bat:DP
## 304  8.274717e-04                  X2B:WHIP
## 1352 8.264388e-04             HBP.pitch:SO9
## 968  8.246152e-04              SF:Age.pitch
## 176  8.111402e-04                     AB:SLG
## 1084 8.108312e-04          W.L..same_year:H9
## 584  8.081983e-04           SO.bat:HBP.pitch
## 74   8.065296e-04            Age.bat:HBP.bat
## 838  8.015494e-04                     TB:WHIP
## 1340 8.008279e-04             SO.pitch:RF.9
## 592  7.981621e-04                SO.bat:BB9
## 299  7.953691e-04             X2B:HBP.pitch
## 814  7.913619e-04              OPSplus:RF.G
## 524  7.885346e-04            BB.bat:HBP.bat
## 1320 7.815715e-04          IBB.pitch:num_fas
## 825  7.813217e-04                     TB:SHO
## 1519 7.810496e-04                     SO.W:G
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## 448  7.745468e-04                   SB:WP
## 1233 7.681044e-04              H.pitch:SO.W
## 1304 7.568768e-04              IBB.pitch:H9
## 1517 7.492285e-04            SO9:tot_fa_war3
## 87   7.484090e-04          Age.bat:IBB.pitch
## 315  7.459848e-04                   X2B:E
## 203  7.425892e-04                  AB:HR9
## 1442 7.374607e-04            FIP:tot_fa_war3
## 1576 7.365886e-04                     E:DP
## 365  7.363438e-04                   X3B:E
## 258  7.319377e-04               H.bat:SO.W
## 1035 7.312438e-04            IBB.bat:num_fas
## 1001 7.309179e-04                 SF:num_fas
## 1381 7.283308e-04                     BK:DP
## 604  7.278021e-04               SO.bat:RF.G
## 1483 7.187282e-04                    HR9:PO
## 337  7.115528e-04               X3B:IBB.bat
## 1142 7.074155e-04                    SHO:BF
## 89   7.049942e-04          Age.bat:HBP.pitch
## 867  7.009842e-04               GDP:HR.pitch
## 693  6.971904e-04                 OBP:num_fas
## 1443 6.945108e-04                 FIP:num_fas
## 98   6.906438e-04                 Age.bat:SO9
## 1492 6.898773e-04                    BB9:SO9
## 939  6.881724e-04                  SH:H.pitch
## 1039 6.784352e-04               Age.pitch:SV
## 1375 6.765166e-04                      BK:G
## 1002 6.758881e-04          IBB.bat:Age.pitch
## 175  6.729914e-04                   AB:OBP
## 1341 6.719390e-04              SO.pitch:RF.G
## 271  6.691417e-04                   X2B:X3B
## 631  6.658134e-04                     BA:BF
## 326  6.654671e-04                  X3B:SO.bat
## 856  6.635772e-04                 GDP:HBP.bat
## 249  6.575477e-04                    H.bat:BK
## 123  6.570580e-04                     PA:SLG
## 1004 6.563581e-04                  IBB.bat:GF
## 80   6.534095e-04                  Age.bat:GF
## 444  6.498050e-04               SB:IBB.pitch
## 1293 6.391702e-04              BB.pitch:RF.9
## 287  6.305372e-04                 X2B:IBB.bat
## 387  6.292167e-04           HR.bat:Age.pitch
## 952  6.286291e-04                   SH:BB9
## 1098 6.284007e-04        W.L..same_year:RF.G
## 331  6.283951e-04                X3B:OPSplus
## 757  6.262555e-04                     OPS:BF
## 477  6.240206e-04                     CS:GDP
## 843  6.185354e-04                    TB:SO.W
## 766  6.155190e-04                    OPS:Inn
## 28   6.144194e-04                         IP
## 76   6.076583e-04                  Age.bat:SF
## 1476 6.072157e-04                  H9:num_fas
## 1564 5.992570e-04                     PO:Fld.
## 482  5.980157e-04               CS:Age.pitch
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## 1337 5.976795e-04                SO.pitch:E
## 1470 5.976258e-04                     H9:E
## 970  5.964493e-04                   SF:GF
## 346  5.959880e-04              X3B:BB.pitch
## 695  5.929763e-04               SLG:OPSplus
## 1243 5.860862e-04              H.pitch:RF.G
## 1053 5.799211e-04             Age.pitch:HR9
## 214  5.798541e-04                   AB:Fld.
## 1537 5.778122e-04                    G:Fld.
## 1378 5.771824e-04                    BK:PO
## 1232 5.761483e-04                H.pitch:SO9
## 938  5.738729e-04                    SH:IP
## 767  5.734853e-04                   OPS:Ch
## 389  5.706777e-04                  HR.bat:GF
## 150  5.675715e-04                     PA:HR9
## 274  5.607230e-04                    X2B:CS
## 997  5.605561e-04                   SF:Fld.
## 433  5.559380e-04                     SB:SF
## 266  5.524709e-04                 H.bat:Fld.
## 1189 5.482149e-04             SV:tot_fa_war3
## 864  5.451451e-04                    GDP:SV
## 1350 5.415385e-04              HBP.pitch:HR9
## 1227 5.377165e-04                H.pitch:FIP
## 301  5.365006e-04                    X2B:WP
## 201  5.362383e-04                   AB:WHIP
## 727  5.358042e-04                    SLG:PO
## 442  5.260819e-04                SB:HR.pitch
## 371  5.234939e-04                X3B:num_fas
## 492  5.214720e-04                CS:SO.pitch
## 831  5.207897e-04               TB:IBB.pitch
## 1349 5.200629e-04               HBP.pitch:H9
## 1216 5.190294e-04                    IP:RF.G
## 1523 5.177208e-04                    SO.W:A
## 603  5.146207e-04                SO.bat:RF.9
## 122  5.012411e-04                    PA:OBP
## 510  4.998312e-04                     CS:DP
## 283  4.934127e-04                   X2B:GDP
## 286  4.932560e-04                    X2B:SF
## 17   4.892402e-04                        TB
## 307  4.826546e-04                   X2B:BB9
## 1188 4.808084e-04                   SV:RF.G
## 776  4.772005e-04                 OPS:num_fas
## 4    4.753136e-04                       H.bat
## 1078 4.742585e-04   W.L..same_year:HBP.pitch
## 594  4.667496e-04                SO.bat:SO.W
## 813  4.629919e-04               OPSplus:RF.9
## 888  4.628262e-04                    GDP:DP
## 1392 4.627744e-04                    WP:BB9
## 467  4.577104e-04             SB:tot_fa_war3
## 898  4.557245e-04     HBP.bat:W.L..same_year
## 285  4.544756e-04                    X2B:SH
## 1231 4.542214e-04                H.pitch:BB9
## 572  4.515570e-04             SO.bat:IBB.bat
## 852  4.493986e-04                    TB:RF.9
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## 642  4.485503e-04                    BA:PO
## 3    4.474997e-04                       AB
## 1449 4.453993e-04                   WHIP:G
## 415  4.436599e-04                 HR.bat:DP
## 897  4.424527e-04          HBP.bat:Age.pitch
## 1131 4.406856e-04                 GF:num_fas
## 571  4.380850e-04                 SO.bat:SF
## 908  4.336485e-04          HBP.bat:HBP.pitch
## 626  4.336124e-04              BA:IBB.pitch
## 1319 4.333437e-04      IBB.pitch:tot_fa_war3
## 105  4.332966e-04                 Age.bat:E
## 585  4.329161e-04                 SO.bat:BK
## 431  4.318319e-04                SB:HBP.bat
## 1153 4.300924e-04                    SHO:PO
## 1200 4.252055e-04                    IP:FIP
## 853  4.247176e-04                   TB:RF.G
## 1482 4.241467e-04                    HR9:Ch
## 1290 4.205543e-04                BB.pitch:E
## 1283 4.201275e-04               BB.pitch:SO9
## 590  4.185776e-04                   SO.bat:H9
## 1484 4.171385e-04                        HR9:A
## 253  4.159250e-04                H.bat:WHIP
## 48   4.149032e-04                         PO
## 1017 4.146424e-04               IBB.bat:FIP
## 229  4.106759e-04                 H.bat:OPS
## 394  4.089632e-04            HR.bat:HR.pitch
## 1278 4.045148e-04               BB.pitch:FIP
## 177  4.023289e-04                    AB:OPS
## 1556 4.005632e-04                  Ch:Fld.
## 1596 3.998051e-04        tot_fa_war3:num_fas
## 535  3.994534e-04            BB.bat:HR.pitch
## 246  3.989889e-04            H.bat:IBB.pitch
## 420  3.931878e-04             HR.bat:num_fas
## 1190 3.924996e-04                 SV:num_fas
## 1525 3.893716e-04                    SO.W:DP
## 798  3.845352e-04               OPSplus:FIP
## 450  3.828377e-04                    SB:FIP
## 905  3.822898e-04          HBP.bat:BB.pitch
## 1475 3.798317e-04            H9:tot_fa_war3
## 435  3.772902e-04              SB:Age.pitch
## 148  3.762446e-04                   PA:WHIP
## 768  3.749928e-04                    OPS:PO
## 1088 3.737164e-04        W.L..same_year:SO.W
## 437  3.703038e-04                     SB:GF
## 528  3.695350e-04           BB.bat:Age.pitch
## 322  3.688160e-04                 X3B:HR.bat
## 625  3.667169e-04               BA:BB.pitch
## 927  3.663474e-04               HBP.bat:RF.9
## 1019 3.573789e-04                 IBB.bat:H9
## 899  3.573221e-04                 HBP.bat:GF
## 1578 3.564410e-04                     E:RF.9
## 996  3.498324e-04                    SF:DP
## 348  3.478696e-04              X3B:SO.pitch
## 1331 3.475944e-04             SO.pitch:SO.W
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## 1329 3.470423e-04              SO.pitch:BB9
## 1249 3.423963e-04         HR.pitch:HBP.pitch
## 1399 3.419935e-04                      WP:A
## 530  3.410681e-04                 BB.bat:GF
## 1152 3.400879e-04                    SHO:Ch
## 1097 3.372083e-04        W.L..same_year:RF.9
## 486  3.353303e-04                     CS:SV
## 1455 3.339588e-04                  WHIP:DP
## 841  3.313983e-04                     TB:BB9
## 1586 3.313968e-04                DP:num_fas
## 1070 3.313620e-04         W.L..same_year:SHO
## 1438 3.310709e-04                     FIP:DP
## 1429 3.284143e-04                  FIP:BB9
## 1452 3.250975e-04                  WHIP:PO
## 1126 3.245846e-04                    GF:DP
## 1453 3.236895e-04                     WHIP:A
## 277  3.215172e-04                     X2B:BA
## 580  3.214034e-04            SO.bat:HR.pitch
## 124  3.173618e-04                     PA:OPS
## 862  3.170281e-04                     GDP:GF
## 1296 3.136596e-04           BB.pitch:num_fas
## 569  3.119518e-04             SO.bat:HBP.bat
## 800  3.119304e-04                 OPSplus:H9
## 1354 3.113272e-04               HBP.pitch:G
## 372  3.071460e-04                 HR.bat:SB
## 804  3.055368e-04               OPSplus:SO.W
## 325  3.051706e-04                 X3B:BB.bat
## 1395 3.025559e-04                       WP:G
## 943  3.015074e-04               SH:SO.pitch
## 1358 2.995027e-04               HBP.pitch:A
## 1000 2.991132e-04            SF:tot_fa_war3
## 623  2.986547e-04                BA:H.pitch
## 1297 2.977218e-04         IBB.pitch:SO.pitch
## 8    2.954228e-04                       SB
## 1360 2.927926e-04              HBP.pitch:DP
## 1313 2.925808e-04               IBB.pitch:A
## 235  2.924201e-04                  H.bat:SF
## 284  2.923712e-04               X2B:HBP.bat
## 63   2.921285e-04                Age.bat:SB
## 1242 2.914711e-04              H.pitch:RF.9
## 188  2.912043e-04                     AB:SHO
## 1012 2.896330e-04           IBB.bat:SO.pitch
## 860  2.875527e-04              GDP:Age.pitch
## 1432 2.873068e-04                      FIP:G
## 2    2.854528e-04                         PA
## 360  2.830142e-04                     X3B:G
## 161  2.825684e-04                  PA:Fld.
## 641  2.825670e-04                     BA:Ch
## 1229 2.812274e-04                  H.pitch:H9
## 871  2.797587e-04              GDP:HBP.pitch
## 430  2.723962e-04                     SB:GDP
## 1271 2.715618e-04           HR.pitch:num_fas
## 586  2.698928e-04                   SO.bat:WP
## 1202 2.686426e-04                      IP:H9
```

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## 1094 2.654423e-04          W.L..same_year:E
## 736  2.650698e-04               OPS:OPSplus
## 796  2.650054e-04                OPSplus:WP
## 223  2.641620e-04                  H.bat:CS
## 1573 2.627371e-04                    A:RF.G
## 513  2.620123e-04                   CS:RF.G
## 1164 2.575320e-04               SV:HR.pitch
## 1165 2.568500e-04               SV:BB.pitch
## 288  2.505373e-04             X2B:Age.pitch
## 819  2.495090e-04                     TB:SH
## 364  2.489427e-04                     X3B:A
## 1087 2.470830e-04        W.L..same_year:SO9
## 303  2.460098e-04                   X2B:FIP
## 1076 2.442942e-04   W.L..same_year:IBB.pitch
## 135  2.408878e-04                    PA:SHO
## 487  2.403064e-04                     CS:IP
## 879  2.392547e-04                   GDP:BB9
## 1074 2.388388e-04    W.L..same_year:HR.pitch
## 1321 2.351364e-04        SO.pitch:HBP.pitch
## 432  2.350583e-04                     SB:SH
## 252  2.346621e-04                 H.bat:FIP
## 49   2.343337e-04                         A
## 267  2.337011e-04                H.bat:RF.9
## 1566 2.336313e-04                   PO:RF.G
## 1280 2.331643e-04               BB.pitch:H9
## 961  2.330264e-04                     SH:DP
## 1071 2.328000e-04         W.L..same_year:SV
## 833  2.323881e-04              TB:HBP.pitch
## 1266 2.307226e-04               HR.pitch:DP
## 77   2.299950e-04           Age.bat:IBB.bat
## 821  2.292493e-04                TB:IBB.bat
## 1507 2.276794e-04                     SO9:G
## 1471 2.265818e-04                     H9:DP
## 452  2.252890e-04                     SB:H9
## 1223 2.248122e-04         H.pitch:HBP.pitch
## 1377 2.233521e-04                     BK:Ch
## 469  2.231174e-04                CS:BB.bat
## 556  2.225957e-04                BB.bat:DP
## 802  2.211257e-04               OPSplus:BB9
## 803  2.204945e-04               OPSplus:SO9
## 1421 2.204645e-04                   BF:Fld.
## 826  2.203291e-04                     TB:SV
## 568  2.200092e-04                SO.bat:GDP
## 1225 2.183610e-04                H.pitch:WP
## 1365 2.174311e-04         HBP.pitch:num_fas
## 1185 2.164571e-04                     SV:DP
## 606  2.159947e-04            SO.bat:num_fas
## 106  2.140456e-04                Age.bat:DP
## 47   2.127459e-04                        Ch
## 1513 2.087940e-04                   SO9:DP
## 220  2.082157e-04                 H.bat:X3B
## 969  2.075657e-04         SF:W.L..same_year
## 887  2.072899e-04                   GDP:E
## 835  2.060122e-04                   TB:WP
```

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## 484  2.053435e-04                   CS:GF
## 71   2.049104e-04            Age.bat:OPSplus
## 1048 2.048660e-04               Age.pitch:WP
## 790  2.046627e-04           OPSplus:HR.pitch
## 86   2.021895e-04           Age.bat:BB.pitch
## 612  2.020966e-04                    BA:GDP
## 527  1.991581e-04             BB.bat:IBB.bat
## 1410 1.985125e-04                    BF:HR9
## 842  1.964574e-04                    TB:SO9
## 60   1.957989e-04               Age.bat:X2B
## 66   1.957099e-04             Age.bat:SO.bat
## 575  1.947481e-04                  SO.bat:GF
## 46   1.937379e-04                        Inn
## 200  1.915284e-04                    AB:FIP
## 363  1.898900e-04                    X3B:PO
## 1436 1.897285e-04                     FIP:A
## 445  1.890867e-04                SB:SO.pitch
## 849  1.889410e-04                       TB:E
## 468  1.846010e-04                 SB:num_fas
## 383  1.821396e-04             HR.bat:HBP.bat
## 1539 1.819880e-04                    G:RF.G
## 78   1.809389e-04          Age.bat:Age.pitch
## 99   1.807652e-04               Age.bat:SO.W
## 216  1.804209e-04                    AB:RF.G
## 837  1.790695e-04                    TB:FIP
## 917  1.773264e-04                HBP.bat:SO9
## 475  1.772834e-04                 CS:OPSplus
## 395  1.764933e-04            HR.bat:BB.pitch
## 443  1.752707e-04                SB:BB.pitch
## 1151 1.739235e-04                    SHO:Inn
## 470  1.736525e-04                 CS:SO.bat
## 979  1.736495e-04               SF:HBP.pitch
## 388  1.735618e-04      HR.bat:W.L..same_year
## 1323 1.713720e-04                SO.pitch:WP
## 1215 1.680613e-04                    IP:RF.9
## 204  1.677717e-04                    AB:BB9
## 1558 1.674010e-04                    Ch:RF.G
## 413  1.673392e-04                   HR.bat:A
## 868  1.669509e-04               GDP:BB.pitch
## 233  1.658582e-04              H.bat:HBP.bat
## 257  1.645221e-04                 H.bat:SO9
## 1292 1.644574e-04              BB.pitch:Fld.
## 890  1.639666e-04                   GDP:RF.9
## 959  1.616507e-04                       SH:A
## 490  1.599141e-04                 CS:BB.pitch
## 232  1.596018e-04                   H.bat:GDP
## 955  1.592636e-04                       SH:G
## 536  1.582475e-04            BB.bat:BB.pitch
## 1272 1.566862e-04         BB.pitch:IBB.pitch
## 934  1.564102e-04          SH:W.L..same_year
## 1172 1.550571e-04                    SV:FIP
## 1538 1.550453e-04                    G:RF.9
## 1269 1.549895e-04              HR.pitch:RF.G
## 582  1.537322e-04           SO.bat:IBB.pitch
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## 785  1.497641e-04                OPSplus:GF
## 1036 1.489757e-04   Age.pitch:W.L..same_year
## 111  1.485453e-04           Age.bat:num_fas
## 1010 1.474162e-04          IBB.bat:BB.pitch
## 1204 1.473678e-04                   IP:BB9
## 508  1.460506e-04                     CS:A
## 779  1.454581e-04           OPSplus:HBP.bat
## 919  1.435547e-04                 HBP.bat:G
## 577  1.428717e-04                 SO.bat:SV
## 1102 1.427781e-04                     GF:SV
## 147  1.415426e-04                   PA:FIP
## 1205 1.412918e-04                   IP:SO9
## 1497 1.411436e-04                   BB9:PO
## 374  1.404034e-04             HR.bat:BB.bat
## 1309 1.366488e-04               IBB.pitch:G
## 892  1.357113e-04           GDP:tot_fa_war3
## 343  1.356402e-04                   X3B:IP
## 923  1.353564e-04                 HBP.bat:A
## 422  1.338154e-04                 SB:BB.bat
## 561  1.335481e-04            BB.bat:num_fas
## 409  1.332893e-04                 HR.bat:G
## 1067 1.330981e-04     Age.pitch:tot_fa_war3
## 397  1.325688e-04           HR.bat:SO.pitch
## 1206 1.301066e-04                   IP:SO.W
## 1565 1.299012e-04                   PO:RF.9
## 268  1.293192e-04                H.bat:RF.G
## 316  1.285784e-04                   X2B:DP
## 215  1.273493e-04                   AB:RF.9
## 1451 1.269333e-04                   WHIP:Ch
## 392  1.269157e-04                 HR.bat:IP
## 1494 1.255487e-04                     BB9:G
## 978  1.248742e-04               SF:SO.pitch
## 1105 1.239332e-04               GF:HR.pitch
## 1571 1.232338e-04                     A:Fld.
## 272  1.227513e-04                X2B:HR.bat
## 483  1.227400e-04         CS:W.L..same_year
## 1500 1.224966e-04                   BB9:DP
## 810  1.218705e-04                OPSplus:E
## 84   1.216008e-04           Age.bat:H.pitch
## 234  1.212908e-04                  H.bat:SH
## 947  1.204504e-04                     SH:BF
## 82   1.193194e-04                Age.bat:SV
## 1198 1.187463e-04                     IP:WP
## 362  1.186017e-04                   X3B:Ch
## 1520 1.169730e-04                  SO.W:Inn
## 153  1.169538e-04                   PA:SO.W
## 1343 1.141544e-04          SO.pitch:num_fas
## 290  1.138589e-04                   X2B:GF
## 440  1.132522e-04                     SB:IP
## 419  1.132076e-04        HR.bat:tot_fa_war3
## 1408 1.130222e-04                   BF:WHIP
## 1028 1.129430e-04                 IBB.bat:A
## 436  1.125148e-04          SB:W.L..same_year
## 305  1.124875e-04                   X2B:H9
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## 839  1.123824e-04                    TB:H9
## 903  1.108756e-04            HBP.bat:H.pitch
## 1422 1.104181e-04                   BF:RF.9
## 1481 1.103571e-04                   HR9:Inn
## 529  1.093533e-04      BB.bat:W.L..same_year
## 581  1.082262e-04             SO.bat:BB.pitch
## 859  1.072736e-04                 GDP:IBB.bat
## 1511 1.072512e-04                     SO9:A
## 423  1.070386e-04                 SB:SO.bat
## 1037 1.045188e-04               Age.pitch:GF
## 902  1.034960e-04                 HBP.bat:IP
## 151  1.034510e-04                    PA:BB9
## 1106 1.030314e-04                GF:BB.pitch
## 488  1.029820e-04                 CS:H.pitch
## 538  1.026346e-04            BB.bat:SO.pitch
## 273  1.024583e-04                   X2B:SB
## 1221 1.011920e-04          H.pitch:IBB.pitch
## 1569 1.006176e-04                      A:E
## 196  1.003748e-04               AB:HBP.pitch
## 110  9.934391e-05        Age.bat:tot_fa_war3
## 1179 9.753955e-05                    SV:G
## 504  9.705442e-05                    CS:G
## 1411 9.697525e-05                   BF:BB9
## 206  9.647619e-05                  AB:SO.W
## 1024 9.647030e-05                 IBB.bat:G
## 1124 9.638666e-05                     GF:A
## 168  9.571200e-05                   AB:X3B
## 1251 9.561957e-05                HR.pitch:WP
## 183  9.463676e-05                    AB:SF
## 1007 9.386407e-05                 IBB.bat:IP
## 241  9.296403e-05                   H.bat:SV
## 163  9.286395e-05                   PA:RF.G
## 1398 9.270711e-05                     WP:PO
## 115  9.160432e-05                   PA:X3B
## 1052 9.085170e-05                Age.pitch:H9
## 1057 9.050613e-05                 Age.pitch:G
## 393  8.961776e-05              HR.bat:H.pitch
## 1330 8.944058e-05                SO.pitch:SO9
## 735  8.896077e-05                 SLG:num_fas
## 62   8.850896e-05              Age.bat:HR.bat
## 1367 8.796059e-05                     BK:BF
## 526  8.789151e-05                  BB.bat:SF
## 1557 8.780452e-05                    Ch:RF.9
## 227  8.699473e-05                  H.bat:OBP
## 441  8.598947e-05                 SB:H.pitch
## 907  8.542487e-05            HBP.bat:SO.pitch
## 222  8.527536e-05                   H.bat:SB
## 171  8.479267e-05                      AB:CS
## 202  8.473288e-05                      AB:H9
## 130  8.468277e-05                      PA:SF
## 1163 8.466958e-05                 SV:H.pitch
## 1468 8.453600e-05                      H9:PO
## 886  8.429292e-05                      GDP:A
## 276  8.362249e-05                 X2B:SO.bat
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## 65   8.286705e-05             Age.bat:BB.bat
## 994  8.232117e-05                      SF:A
## 1327 8.171930e-05                 SO.pitch:H9
## 1390 8.152914e-05                       WP:H9
## 457  8.093519e-05                       SB:G
## 780  8.057244e-05                  OPSplus:SH
## 1045 7.870598e-05          Age.pitch:SO.pitch
## 1282 7.863507e-05                BB.pitch:BB9
## 1397 7.818937e-05                       WP:Ch
## 840  7.788825e-05                      TB:HR9
## 118  7.752014e-05                       PA:CS
## 1069 7.735575e-05           W.L..same_year:GF
## 1389 7.648264e-05                     WP:WHIP
## 1547 7.629956e-05                    Inn:Fld.
## 818  7.566267e-05                  TB:HBP.bat
## 601  7.537079e-05                   SO.bat:DP
## 463  7.497276e-05                       SB:DP
## 861  7.434747e-05          GDP:W.L..same_year
## 1130 7.396017e-05              GF:tot_fa_war3
## 1465 7.395281e-05                       H9:G
## 1521 7.365523e-05                    SO.W:Ch
## 254  7.262269e-05                  H.bat:H9
## 1325 7.236042e-05                 SO.pitch:FIP
## 1003 7.183616e-05     IBB.bat:W.L..same_year
## 1276 7.131245e-05                BB.pitch:WP
## 1419 7.011168e-05                       BF:E
## 1496 6.977626e-05                     BB9:Ch
## 143  6.965306e-05                PA:HBP.pitch
## 1291 6.886328e-05                 BB.pitch:DP
## 79   6.848578e-05     Age.bat:W.L..same_year
## 298  6.847980e-05                X2B:SO.pitch
## 822  6.826665e-05                TB:Age.pitch
## 778  6.820307e-05                 OPSplus:GDP
## 198  6.777125e-05                       AB:WP
## 83   6.762549e-05                  Age.bat:IP
## 1043 6.647314e-05          Age.pitch:BB.pitch
## 550  6.628283e-05                   BB.bat:G
## 1008 6.589030e-05             IBB.bat:H.pitch
## 248  6.544999e-05             H.bat:HBP.pitch
## 1264 6.478274e-05                  HR.pitch:A
## 533  6.414536e-05                   BB.bat:IP
## 794  6.409223e-05           OPSplus:HBP.pitch
## 1450 6.349764e-05                     WHIP:Inn
## 829  6.342586e-05                 TB:HR.pitch
## 244  6.305232e-05              H.bat:HR.pitch
## 1196 6.284314e-05                IP:HBP.pitch
## 182  6.250781e-05                       AB:SH
## 1218 6.222847e-05                  IP:num_fas
## 1346 6.222304e-05                HBP.pitch:BF
## 181  6.125435e-05                  AB:HBP.bat
## 1245 6.097665e-05             H.pitch:num_fas
## 320  6.086671e-05             X2B:tot_fa_war3
## 149  6.038197e-05                       PA:H9
## 554  6.028612e-05                   BB.bat:A
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## 824  5.968625e-05                     TB:GF
## 264  5.780390e-05                   H.bat:E
## 1423 5.754613e-05                   BF:RF.G
## 974  5.648948e-05                SF:H.pitch
## 1068 5.634072e-05          Age.pitch:num_fas
## 885  5.608183e-05                    GDP:PO
## 1562 5.603033e-05                      PO:E
## 1104 5.595509e-05                GF:H.pitch
## 1095 5.503363e-05          W.L..same_year:DP
## 289  5.443001e-05         X2B:W.L..same_year
## 791  5.396726e-05           OPSplus:BB.pitch
## 973  5.311934e-05                     SF:IP
## 1274 5.307329e-05         BB.pitch:HBP.pitch
## 1387 5.300356e-05                     WP:BF
## 1099 5.297698e-05 W.L..same_year:tot_fa_war3
## 162  5.230466e-05                   PA:RF.9
## 1522 5.181643e-05                   SO.W:PO
## 221  5.162537e-05              H.bat:HR.bat
## 534  5.148858e-05             BB.bat:H.pitch
## 180  5.044318e-05                    AB:GDP
## 310  5.035847e-05                     X2B:G
## 128  4.998720e-05                 PA:HBP.bat
## 129  4.923900e-05                      PA:SH
## 1108 4.886910e-05                GF:SO.pitch
## 1120 4.880070e-05                       GF:G
## 866  4.874293e-05                GDP:H.pitch
## 1435 4.847713e-05                     FIP:PO
## 882  4.828827e-05                      GDP:G
## 1376 4.803765e-05                     BK:Inn
## 1467 4.802092e-05                      H9:Ch
## 1260 4.790447e-05                 HR.pitch:G
## 560  4.787099e-05         BB.bat:tot_fa_war3
## 100  4.769346e-05                  Age.bat:G
## 1294 4.728090e-05               BB.pitch:RF.G
## 1342 4.704101e-05       SO.pitch:tot_fa_war3
## 1572 4.649661e-05                     A:RF.9
## 1498 4.622143e-05                     BB9:A
## 314  4.617740e-05                     X2B:A
## 256  4.611159e-05                 H.bat:BB9
## 59   4.597543e-05              Age.bat:H.bat
## 212  4.579821e-05                       AB:E
## 127  4.548795e-05                    PA:GDP
## 1326 4.537201e-05              SO.pitch:WHIP
## 976  4.511474e-05                SF:BB.pitch
## 375  4.501144e-05              HR.bat:SO.bat
## 1541 4.487168e-05                  G:num_fas
## 141  4.476336e-05               PA:IBB.pitch
## 344  4.468197e-05                X3B:H.pitch
## 1355 4.432022e-05              HBP.pitch:Inn
## 192  4.430856e-05                AB:HR.pitch
## 428  4.415954e-05                SB:OPSplus
## 993  4.383941e-05                     SF:PO
## 239  4.376342e-05                  H.bat:GF
## 104  4.365982e-05                  Age.bat:A
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## 145  4.358102e-05                   PA:WP
## 1554 4.320078e-05                    Ch:E
## 1338 4.267189e-05              SO.pitch:DP
## 792  4.254388e-05         OPSplus:IBB.pitch
## 1061 4.253934e-05               Age.pitch:A
## 1580 4.237149e-05             E:tot_fa_war3
## 1040 4.224073e-05              Age.pitch:IP
## 1396 4.214743e-05                   WP:Inn
## 1575 4.213523e-05                A:num_fas
## 293  4.209571e-05                   X2B:IP
## 1510 4.203889e-05                   SO9:PO
## 1162 4.181497e-05                    SV:IP
## 270  4.172452e-05             H.bat:num_fas
## 781  4.166075e-05                OPSplus:SF
## 461  4.162182e-05                     SB:A
## 1585 4.080051e-05            DP:tot_fa_war3
## 496  4.048803e-05                    CS:BF
## 1082 4.015039e-05        W.L..same_year:FIP
## 37   3.979522e-05                      BF
## 1213 3.945465e-05                   IP:DP
## 1469 3.945003e-05                    H9:A
## 1248 3.923675e-05         HR.pitch:SO.pitch
## 870  3.921637e-05              GDP:SO.pitch
## 321  3.901197e-05               X2B:num_fas
## 1239 3.884051e-05                 H.pitch:E
## 1044 3.880611e-05       Age.pitch:IBB.pitch
## 194  3.860553e-05              AB:IBB.pitch
## 820  3.843005e-05                   TB:SF
## 593  3.796558e-05               SO.bat:SO9
## 782  3.768106e-05           OPSplus:IBB.bat
## 815  3.749006e-05       OPSplus:tot_fa_war3
## 1536 3.734140e-05                   G:DP
## 352  3.684814e-05                  X3B:BF
## 1356 3.634322e-05              HBP.pitch:Ch
## 787  3.612712e-05                OPSplus:SV
## 1433 3.610074e-05                   FIP:Inn
## 1407 3.583610e-05                   BF:FIP
## 1212 3.573750e-05                     IP:E
## 281  3.571755e-05              X2B:OPSplus
## 1301 3.545660e-05              IBB.pitch:BF
## 784  3.499380e-05    OPSplus:W.L..same_year
## 884  3.484417e-05                  GDP:Ch
## 103  3.476817e-05               Age.bat:PO
## 600  3.450507e-05                 SO.bat:E
## 579  3.435583e-05           SO.bat:H.pitch
## 197  3.410981e-05                   AB:BK
## 139  3.401964e-05              PA:HR.pitch
## 58   3.361772e-05               Age.bat:AB
## 573  3.334352e-05          SO.bat:Age.pitch
## 1568 3.327881e-05                PO:num_fas
## 1508 3.305889e-05                   SO9:Inn
## 1073 3.194848e-05    W.L..same_year:H.pitch
## 605  3.179452e-05        SO.bat:tot_fa_war3
## 1413 3.178404e-05                  BF:SO.W
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## 218  3.168291e-05                AB:num_fas
## 1167 3.166324e-05               SV:SO.pitch
## 1123 3.129430e-05                     GF:PO
## 1311 3.084223e-05               IBB.pitch:Ch
## 250  3.058992e-05                  H.bat:WP
## 187  3.014896e-05                     AB:GF
## 361  2.981462e-05                   X3B:Inn
## 850  2.981213e-05                     TB:DP
## 1063 2.878567e-05              Age.pitch:DP
## 1563 2.878357e-05                     PO:DP
## 1535 2.877034e-05                       G:E
## 783  2.875620e-05          OPSplus:Age.pitch
## 992  2.810457e-05                     SF:Ch
## 1240 2.796949e-05                H.pitch:DP
## 507  2.755283e-05                     CS:PO
## 1530 2.745664e-05              SO.W:num_fas
## 990  2.738168e-05                      SF:G
## 1192 2.687412e-05               IP:HR.pitch
## 1570 2.626546e-05                      A:DP
## 401  2.625689e-05                HR.bat:BF
## 57   2.615109e-05                Age.bat:PA
## 506  2.574634e-05                     CS:Ch
## 1103 2.551337e-05                     GF:IP
## 237  2.530098e-05           H.bat:Age.pitch
## 170  2.521187e-05                     AB:SB
## 1122 2.502603e-05                     GF:Ch
## 411  2.443364e-05                HR.bat:Ch
## 275  2.439652e-05                X2B:BB.bat
## 219  2.424183e-05                H.bat:X2B
## 332  2.415425e-05                   X3B:TB
## 102  2.413534e-05                Age.bat:Ch
## 1100 2.400971e-05     W.L..same_year:num_fas
## 1357 2.390393e-05               HBP.pitch:PO
## 793  2.388264e-05           OPSplus:SO.pitch
## 449  2.364022e-05                     SB:BF
## 134  2.333684e-05                     PA:GF
## 1285 2.332965e-05                BB.pitch:G
## 225  2.331337e-05              H.bat:SO.bat
## 521  2.311651e-05            BB.bat:OPSplus
## 144  2.311133e-05                     PA:BK
## 165  2.310348e-05                PA:num_fas
## 117  2.297990e-05                     PA:SB
## 1310 2.287156e-05              IBB.pitch:Inn
## 245  2.273836e-05             H.bat:BB.pitch
## 1295 2.269627e-05       BB.pitch:tot_fa_war3
## 830  2.269076e-05                TB:BB.pitch
## 1560 2.193730e-05                Ch:num_fas
## 92   2.144789e-05                Age.bat:BF
## 72   2.125807e-05                Age.bat:TB
## 1332 2.125200e-05                SO.pitch:G
## 88   2.117960e-05           Age.bat:SO.pitch
## 816  2.093232e-05            OPSplus:num_fas
## 476  2.062614e-05                     CS:TB
## 1273 2.052851e-05          BB.pitch:SO.pitch
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## 1548 2.041598e-05                 Inn:RF.9
## 412  2.040467e-05                HR.bat:PO
## 159  2.025126e-05                     PA:E
## 920  2.024930e-05               HBP.bat:Inn
## 1042 2.013641e-05       Age.pitch:HR.pitch
## 578  2.000044e-05                SO.bat:IP
## 1284 1.977954e-05            BB.pitch:SO.W
## 789  1.977934e-05          OPSplus:H.pitch
## 1540 1.907327e-05            G:tot_fa_war3
## 295  1.890096e-05             X2B:HR.pitch
## 1025 1.809423e-05               IBB.bat:Inn
## 1555 1.807595e-05                    Ch:DP
## 957  1.801290e-05                    SH:Ch
## 921  1.800912e-05              HBP.bat:Ch
## 566  1.791269e-05           SO.bat:OPSplus
## 1289 1.772601e-05               BB.pitch:A
## 213  1.756169e-05                    AB:DP
## 294  1.738370e-05              X2B:H.pitch
## 410  1.730563e-05               HR.bat:Inn
## 1549 1.656037e-05                 Inn:RF.G
## 516  1.606940e-05            BB.bat:SO.bat
## 193  1.605306e-05              AB:BB.pitch
## 1089 1.601379e-05         W.L..same_year:G
## 823  1.584787e-05        TB:W.L..same_year
## 832  1.584063e-05              TB:SO.pitch
## 1336 1.583041e-05               SO.pitch:A
## 1412 1.580681e-05                   BF:SO9
## 1574 1.548738e-05            A:tot_fa_war3
## 1077 1.538083e-05   W.L..same_year:SO.pitch
## 788  1.529026e-05               OPSplus:IP
## 230  1.481459e-05            H.bat:OPSplus
## 1509 1.463093e-05                  SO9:Ch
## 169  1.450049e-05                AB:HR.bat
## 1194 1.442952e-05              IP:IBB.pitch
## 522  1.434915e-05                 BB.bat:TB
## 958  1.415108e-05                     SH:PO
## 542  1.411162e-05                 BB.bat:BF
## 1220 1.401717e-05          H.pitch:BB.pitch
## 570  1.381628e-05                SO.bat:SH
## 827  1.355467e-05                    TB:IP
## 817  1.345518e-05                   TB:GDP
## 844  1.322912e-05                     TB:G
## 205  1.309693e-05                   AB:SO9
## 595  1.295091e-05                 SO.bat:G
## 553  1.287580e-05                 BB.bat:PO
## 116  1.284316e-05                 PA:HR.bat
## 598  1.251577e-05                 SO.bat:PO
## 1312 1.244878e-05              IBB.pitch:PO
## 265  1.222671e-05                  H.bat:DP
## 460  1.200917e-05                     SB:PO
## 848  1.193939e-05                      TB:A
## 552  1.186199e-05                BB.bat:Ch
## 140  1.182165e-05              PA:BB.pitch
## 1016 1.182146e-05                IBB.bat:BF
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## 583  1.165288e-05            SO.bat:SO.pitch
## 1180 1.158468e-05                    SV:Inn
## 1246 1.156415e-05          HR.pitch:BB.pitch
## 1182 1.120023e-05                    SV:PO
## 131  1.109726e-05                 PA:IBB.bat
## 1058 1.088397e-05               Age.pitch:Inn
## 160  1.064717e-05                    PA:DP
## 828  1.062388e-05                 TB:H.pitch
## 922  1.057660e-05                 HBP.bat:PO
## 1252 1.052722e-05                HR.pitch:BF
## 458  1.049784e-05                    SB:Inn
## 459  1.042324e-05                    SB:Ch
## 1238 1.024900e-05                  H.pitch:A
## 1112 1.023608e-05                    GF:BF
## 1222 9.917059e-06           H.pitch:SO.pitch
## 1495 9.756034e-06                    BB9:Inn
## 854  9.704180e-06              TB:tot_fa_war3
## 1234 9.388556e-06                   H.pitch:G
## 167  9.155000e-06                    AB:X2B
## 874  9.086748e-06                    GDP:BF
## 1261 8.872393e-06                HR.pitch:Inn
## 982  8.788464e-06                    SF:BF
## 1211 8.716962e-06                     IP:A
## 114  8.590790e-06                    PA:X2B
## 808  8.485931e-06                 OPSplus:PO
## 956  8.455752e-06                    SH:Inn
## 855  8.399904e-06                 TB:num_fas
## 599  8.280189e-06                   SO.bat:A
## 236  8.194798e-06               H.bat:IBB.bat
## 1080 8.123855e-06          W.L..same_year:WP
## 302  8.091097e-06                    X2B:BF
## 136  8.077890e-06                     PA:SV
## 551  8.027547e-06                 BB.bat:Inn
## 152  8.010573e-06                    PA:SO9
## 1041 7.873554e-06          Age.pitch:H.pitch
## 446  7.847649e-06               SB:HBP.pitch
## 1425 7.793106e-06                 BF:num_fas
## 1262 7.587349e-06                HR.pitch:Ch
## 883  7.462188e-06                    GDP:Inn
## 597  7.441205e-06                  SO.bat:Ch
## 173  7.392348e-06                  AB:SO.bat
## 1551 7.228549e-06                 Inn:num_fas
## 1420 7.223378e-06                      BF:DP
## 238  7.155082e-06       H.bat:W.L..same_year
## 1121 7.111692e-06                    GF:Inn
## 185  7.073379e-06              AB:Age.pitch
## 247  7.051772e-06             H.bat:SO.pitch
## 805  6.963972e-06                  OPSplus:G
## 1027 6.857917e-06                 IBB.bat:PO
## 311  6.638327e-06                    X2B:Inn
## 269  6.576482e-06          H.bat:tot_fa_war3
## 120  6.487521e-06                  PA:SO.bat
## 1181 6.468921e-06                     SV:Ch
## 1466 6.422284e-06                     H9:Inn
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## 1263 6.417405e-06               HR.pitch:PO
## 505  6.415325e-06                    CS:Inn
## 1092 6.301098e-06         W.L..same_year:PO
## 224  6.262124e-06              H.bat:BB.bat
## 811  6.202880e-06                OPSplus:DP
## 1217 6.196101e-06            IP:tot_fa_war3
## 587  6.136034e-06                 SO.bat:BF
## 925  6.080273e-06               HBP.bat:DP
## 1093 5.878425e-06          W.L..same_year:A
## 1561 5.751954e-06                      PO:A
## 184  5.689650e-06               AB:IBB.bat
## 243  5.571398e-06             H.bat:H.pitch
## 1270 5.555015e-06      HR.pitch:tot_fa_war3
## 101  5.520366e-06               Age.bat:Inn
## 1049 5.511170e-06             Age.pitch:BF
## 178  5.477542e-06               AB:OPSplus
## 1277 5.475824e-06             BB.pitch:BF
## 809  5.325520e-06                OPSplus:A
## 186  5.304166e-06          AB:W.L..same_year
## 1409 5.119341e-06                     BF:H9
## 191  4.893505e-06               AB:H.pitch
## 1414 4.852927e-06                     BF:G
## 429  4.804845e-06                     SB:TB
## 125  4.752680e-06               PA:OPSplus
## 1546 4.734100e-06                   Inn:DP
## 1195 4.631481e-06             IP:SO.pitch
## 567  4.531476e-06                 SO.bat:TB
## 1193 4.530492e-06             IP:BB.pitch
## 865  4.528412e-06                  GDP:IP
## 1026 4.458800e-06               IBB.bat:Ch
## 1237 4.454026e-06               H.pitch:PO
## 797  4.379934e-06               OPSplus:BF
## 1060 4.378265e-06             Age.pitch:PO
## 1545 4.343516e-06                    Inn:E
## 231  4.219883e-06                H.bat:TB
## 807  4.069654e-06               OPSplus:Ch
## 312  4.052573e-06                   X2B:Ch
## 296  4.028201e-06             X2B:BB.pitch
## 1324 4.018968e-06              SO.pitch:BF
## 1210 3.852341e-06                    IP:PO
## 381  3.836062e-06                HR.bat:TB
## 138  3.727387e-06               PA:H.pitch
## 133  3.707168e-06          PA:W.L..same_year
## 574  3.699848e-06       SO.bat:W.L..same_year
## 1075 3.502798e-06    W.L..same_year:BB.pitch
## 211  3.481665e-06                      AB:A
## 282  3.450562e-06                   X2B:TB
## 132  3.438025e-06             PA:Age.pitch
## 1236 3.399110e-06               H.pitch:Ch
## 1335 3.366439e-06              SO.pitch:PO
## 1333 3.309089e-06             SO.pitch:Inn
## 207  3.288784e-06                     AB:G
## 1286 3.204646e-06             BB.pitch:Inn
## 1553 3.143911e-06                     Ch:A
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## 190  3.123168e-06                   AB:IP
## 1334 3.121029e-06               SO.pitch:Ch
## 1533 3.116500e-06                     G:PO
## 1567 3.113470e-06            PO:tot_fa_war3
## 1091 3.031863e-06          W.L..same_year:Ch
## 1434 2.935689e-06                  FIP:Ch
## 259  2.876060e-06                 H.bat:G
## 836  2.829209e-06                   TB:BF
## 1209 2.751616e-06                   IP:Ch
## 1559 2.616752e-06            Ch:tot_fa_war3
## 1418 2.558274e-06                    BF:A
## 1424 2.499321e-06            BF:tot_fa_war3
## 1219 2.452964e-06           H.pitch:HR.pitch
## 262  2.423079e-06                 H.bat:PO
## 911  2.334424e-06               HBP.bat:BF
## 1081 2.291312e-06          W.L..same_year:BF
## 189  2.248313e-06                   AB:SV
## 210  2.205604e-06                   AB:PO
## 846  2.195193e-06                   TB:Ch
## 137  2.165894e-06                   PA:IP
## 166  2.134473e-06                 AB:H.bat
## 847  2.109028e-06                   TB:PO
## 172  2.108263e-06                AB:BB.bat
## 119  2.005593e-06                PA:BB.bat
## 1090 1.989133e-06         W.L..same_year:Inn
## 113  1.966879e-06                 PA:H.bat
## 1207 1.892885e-06                     IP:G
## 158  1.866003e-06                    PA:A
## 1059 1.822710e-06              Age.pitch:Ch
## 1171 1.822542e-06                   SV:BF
## 1550 1.798915e-06            Inn:tot_fa_war3
## 1532 1.786121e-06                   G:Ch
## 1552 1.739934e-06                   Ch:PO
## 195  1.706538e-06                AB:SO.pitch
## 845  1.690957e-06                    TB:Inn
## 1287 1.687465e-06                BB.pitch:Ch
## 154  1.667824e-06                    PA:G
## 777  1.539710e-06               OPSplus:TB
## 1534 1.523113e-06                     G:A
## 157  1.482559e-06                   PA:PO
## 263  1.465015e-06                  H.bat:A
## 209  1.450056e-06                   AB:Ch
## 596  1.420792e-06                 SO.bat:Inn
## 179  1.387271e-06                    AB:TB
## 1226 1.312579e-06                H.pitch:BF
## 1244 1.282794e-06         H.pitch:tot_fa_war3
## 126  1.261035e-06                   PA:TB
## 261  1.216937e-06                  H.bat:Ch
## 523  1.216539e-06                BB.bat:GDP
## 1235 1.076339e-06               H.pitch:Inn
## 380  1.070485e-06              HR.bat:OPSplus
## 199  1.008874e-06                   AB:BF
## 217  9.528180e-07              AB:tot_fa_war3
## 156  9.479808e-07                   PA:Ch
```

```
## 112  9.288333e-07                     PA:AB
## 1072 9.263120e-07          W.L..same_year:IP
## 1417 9.223970e-07                     BF:PO
## 1191 8.778447e-07                IP:H.pitch
## 1531 8.748933e-07                     G:Inn
## 164  8.119396e-07             PA:tot_fa_war3
## 1416 7.492155e-07                     BF:Ch
## 991  7.093821e-07                    SF:Inn
## 1288 7.053189e-07                BB.pitch:PO
## 146  6.668828e-07                     PA:BF
## 1415 6.440996e-07                    BF:Inn
## 313  5.273150e-07                    X2B:PO
## 806  4.595615e-07                OPSplus:Inn
## 1543 4.402020e-07                     Inn:PO
## 242  4.382009e-07                   H.bat:IP
## 142  4.358008e-07                SO.pitch:PA
## 251  4.270852e-07                   H.bat:BF
## 208  3.897273e-07                     AB:Inn
## 260  3.869553e-07                   H.bat:Inn
## 1183 3.322858e-07                        SV:A
## 1542 2.511107e-07                    Inn:Ch
## 1208 2.318063e-07                    IP:Inn
## 155  1.901093e-07                    PA:Inn
## 1544 1.400711e-07                     Inn:A
## 1199 7.804395e-08                     IP:BF
```

```
X.fullinteraction.test = model.matrix(lm.fullinteraction, data=test.df)[,-1] # drop intercept

yhats.fullinteraction.train = predict(ridges.fullinteraction, X.fullinteraction)
ridgesfullinteraction.trainRMSE = RMSE(train.df$W.L..next_year, yhats.fullinteraction.train) # train RM
ridgesfullinteraction.trainR2 = R2(train.df$W.L..next_year, yhats.fullinteraction.train) # train R2

yhats.fullinteraction.test = predict(ridges.fullinteraction, X.fullinteraction.test)
#plot(RMSE.ridges.fullinteraction.test~log(ridges.fullinteraction$lambda, 10), type='l')
ridgesfullinteraction.testRMSE = RMSE(test.df$W.L..next_year, yhats.fullinteraction.test) # train RMSE
ridgesfullinteraction.testR2 = R2(test.df$W.L..next_year, yhats.fullinteraction.test) # train R2
```

```
# Lasso Regression
# regularize full model
set.seed(139)
best_lambda = cv.glmnet(X.full, train.df$W.L..next_year, alpha=1,
                        lambda=10^seq(-4, 4, 0.1))$lambda.min; best_lambda
```

```
## [1] 0.1584893
```

```
lassos.full = glmnet(X.full, train.df$W.L..next_year, alpha=1,
                     lambda=best_lambda)
imp <- as.data.frame(varImp(lassos.full, lambda=best_lambda))
imp <- data.frame(overall = imp$Overall,
           names = rownames(imp))
imp[order(imp$overall,decreasing = T),]
```

```
##         overall          names
```

```
## 13 24.107537912            OBP
## 26  6.089623025            SHO
## 35  2.669471333             BK
## 54  1.719169724          RF.G
## 41  1.684140137            HR9
## 40  1.620526168             H9
## 44  1.145888886          SO.W
## 6   0.897012065            X3B
## 1   0.783711896        Age.bat
## 23  0.624232980      Age.pitch
## 38  0.514754448            FIP
## 7   0.348139693         HR.bat
## 22  0.338119435        IBB.bat
## 50  0.303602985              E
## 18  0.289561250            GDP
## 10  0.244886689         BB.bat
## 27  0.237998571             SV
## 30  0.223630740       HR.pitch
## 56  0.141815702        num_fas
## 11  0.100287382         SO.bat
## 55  0.085315446    tot_fa_war3
## 34  0.062146536      HBP.pitch
## 33  0.032307819       SO.pitch
## 24  0.031355893 W.L..same_year
## 3   0.004397218             AB
## 2   0.000000000             PA
## 4   0.000000000          H.bat
## 5   0.000000000            X2B
## 8   0.000000000             SB
## 9   0.000000000             CS
## 12  0.000000000             BA
## 14  0.000000000            SLG
## 15  0.000000000            OPS
## 16  0.000000000        OPSplus
## 17  0.000000000             TB
## 19  0.000000000        HBP.bat
## 20  0.000000000             SH
## 21  0.000000000             SF
## 25  0.000000000             GF
## 28  0.000000000             IP
## 29  0.000000000        H.pitch
## 31  0.000000000       BB.pitch
## 32  0.000000000      IBB.pitch
## 36  0.000000000             WP
## 37  0.000000000             BF
## 39  0.000000000           WHIP
## 42  0.000000000            BB9
## 43  0.000000000            SO9
## 45  0.000000000              G
## 46  0.000000000            Inn
## 47  0.000000000             Ch
## 48  0.000000000             PO
## 49  0.000000000              A
## 51  0.000000000             DP
```

```
## 52  0.000000000           Fld.
## 53  0.000000000           RF.9
```

```
yhats.full.train = predict(lassos.full, X.full)
lassosfull.trainRMSE = RMSE(train.df$W.L..next_year, yhats.full.train) # train RMSE
lassosfull.trainR2 = R2(train.df$W.L..next_year, yhats.full.train) # train R2

yhats.full.test = predict(lassos.full, X.full.test)
#plot(RMSE.lassos.full.test~log(ridges.full$lambda, 10), type='l')
lassosfull.testRMSE = RMSE(test.df$W.L..next_year, yhats.full.test) # test RMSE
lassosfull.testR2 = R2(test.df$W.L..next_year, yhats.full.test) # test RMSE
```

```
# regularize full interaction model
set.seed(139)
best_lambda = cv.glmnet(X.fullinteraction, train.df$W.L..next_year, alpha=1,
                        lambda=10^seq(-4, 4, 0.1))$lambda.min; best_lambda
```

```
## [1] 0.2511886
```

```
lassos.fullinteraction = glmnet(X.fullinteraction, train.df$W.L..next_year, alpha=1,
                     lambda=best_lambda)
imp <- as.data.frame(varImp(lassos.fullinteraction, lambda=best_lambda))
imp <- data.frame(overall = imp$Overall,
           names = rownames(imp))
imp[order(imp$overall,decreasing = T),]
```

```
##           overall                    names
## 1371 2.346024e+00                   BK:HR9
## 660  9.973764e-01             OBP:Age.pitch
## 1155 7.696274e-01                     SHO:E
## 936  6.803169e-01                   SH:SHO
## 356  4.321907e-01                  X3B:HR9
## 23   1.909869e-01                Age.pitch
## 408  8.108638e-02               HR.bat:SO.W
## 1524 7.534380e-02                    SO.W:E
## 95   4.846365e-02               Age.bat:H9
## 109  4.553594e-02              Age.bat:RF.G
## 591  3.467231e-02                SO.bat:HR9
## 396  2.716591e-02          HR.bat:IBB.pitch
## 386  2.024855e-02            HR.bat:IBB.bat
## 548  1.914907e-02                BB.bat:SO9
## 1529 1.627619e-02          SO.W:tot_fa_war3
## 1364 1.405071e-02     HBP.pitch:tot_fa_war3
## 893  1.035156e-02               GDP:num_fas
## 61   9.803812e-03               Age.bat:X3B
## 532  5.871044e-03                 BB.bat:SV
## 414  4.617627e-03                 HR.bat:E
## 203  4.212540e-03                   AB:HR9
## 555  3.664124e-03                 BB.bat:E
## 568  2.118655e-03               SO.bat:GDP
## 606  1.554085e-03            SO.bat:num_fas
## 1012 1.290469e-03          IBB.bat:SO.pitch
```

```
## 1036 1.091877e-03   Age.pitch:W.L..same_year
## 580  5.689129e-04            SO.bat:HR.pitch
## 528  2.746300e-04          BB.bat:Age.pitch
## 588  1.751552e-04                SO.bat:FIP
## 391  4.580819e-05                 HR.bat:SV
## 1133 6.009151e-06                    SHO:IP
## 1    0.000000e+00                   Age.bat
## 2    0.000000e+00                        PA
## 3    0.000000e+00                        AB
## 4    0.000000e+00                     H.bat
## 5    0.000000e+00                       X2B
## 6    0.000000e+00                       X3B
## 7    0.000000e+00                     HR.bat
## 8    0.000000e+00                        SB
## 9    0.000000e+00                        CS
## 10   0.000000e+00                     BB.bat
## 11   0.000000e+00                     SO.bat
## 12   0.000000e+00                        BA
## 13   0.000000e+00                       OBP
## 14   0.000000e+00                       SLG
## 15   0.000000e+00                       OPS
## 16   0.000000e+00                   OPSplus
## 17   0.000000e+00                        TB
## 18   0.000000e+00                       GDP
## 19   0.000000e+00                   HBP.bat
## 20   0.000000e+00                        SH
## 21   0.000000e+00                        SF
## 22   0.000000e+00                   IBB.bat
## 24   0.000000e+00             W.L..same_year
## 25   0.000000e+00                        GF
## 26   0.000000e+00                       SHO
## 27   0.000000e+00                        SV
## 28   0.000000e+00                        IP
## 29   0.000000e+00                   H.pitch
## 30   0.000000e+00                  HR.pitch
## 31   0.000000e+00                  BB.pitch
## 32   0.000000e+00                 IBB.pitch
## 33   0.000000e+00                  SO.pitch
## 34   0.000000e+00                 HBP.pitch
## 35   0.000000e+00                        BK
## 36   0.000000e+00                        WP
## 37   0.000000e+00                        BF
## 38   0.000000e+00                       FIP
## 39   0.000000e+00                      WHIP
## 40   0.000000e+00                        H9
## 41   0.000000e+00                       HR9
## 42   0.000000e+00                       BB9
## 43   0.000000e+00                       SO9
## 44   0.000000e+00                      SO.W
## 45   0.000000e+00                         G
## 46   0.000000e+00                       Inn
## 47   0.000000e+00                        Ch
## 48   0.000000e+00                        PO
## 49   0.000000e+00                         A
```

```
## 50   0.000000e+00                         E
## 51   0.000000e+00                        DP
## 52   0.000000e+00                      Fld.
## 53   0.000000e+00                      RF.9
## 54   0.000000e+00                      RF.G
## 55   0.000000e+00                 tot_fa_war3
## 56   0.000000e+00                     num_fas
## 57   0.000000e+00                  Age.bat:PA
## 58   0.000000e+00                  Age.bat:AB
## 59   0.000000e+00               Age.bat:H.bat
## 60   0.000000e+00                 Age.bat:X2B
## 62   0.000000e+00               Age.bat:HR.bat
## 63   0.000000e+00                  Age.bat:SB
## 64   0.000000e+00                  Age.bat:CS
## 65   0.000000e+00               Age.bat:BB.bat
## 66   0.000000e+00               Age.bat:SO.bat
## 67   0.000000e+00                  Age.bat:BA
## 68   0.000000e+00                 Age.bat:OBP
## 69   0.000000e+00                 Age.bat:SLG
## 70   0.000000e+00                 Age.bat:OPS
## 71   0.000000e+00             Age.bat:OPSplus
## 72   0.000000e+00                  Age.bat:TB
## 73   0.000000e+00                 Age.bat:GDP
## 74   0.000000e+00             Age.bat:HBP.bat
## 75   0.000000e+00                  Age.bat:SH
## 76   0.000000e+00                  Age.bat:SF
## 77   0.000000e+00             Age.bat:IBB.bat
## 78   0.000000e+00          Age.bat:Age.pitch
## 79   0.000000e+00     Age.bat:W.L..same_year
## 80   0.000000e+00                  Age.bat:GF
## 81   0.000000e+00                 Age.bat:SHO
## 82   0.000000e+00                  Age.bat:SV
## 83   0.000000e+00                  Age.bat:IP
## 84   0.000000e+00             Age.bat:H.pitch
## 85   0.000000e+00            Age.bat:HR.pitch
## 86   0.000000e+00            Age.bat:BB.pitch
## 87   0.000000e+00           Age.bat:IBB.pitch
## 88   0.000000e+00            Age.bat:SO.pitch
## 89   0.000000e+00           Age.bat:HBP.pitch
## 90   0.000000e+00                  Age.bat:BK
## 91   0.000000e+00                  Age.bat:WP
## 92   0.000000e+00                  Age.bat:BF
## 93   0.000000e+00                 Age.bat:FIP
## 94   0.000000e+00                Age.bat:WHIP
## 96   0.000000e+00                 Age.bat:HR9
## 97   0.000000e+00                 Age.bat:BB9
## 98   0.000000e+00                 Age.bat:SO9
## 99   0.000000e+00                Age.bat:SO.W
## 100  0.000000e+00                   Age.bat:G
## 101  0.000000e+00                 Age.bat:Inn
## 102  0.000000e+00                  Age.bat:Ch
## 103  0.000000e+00                  Age.bat:PO
## 104  0.000000e+00                   Age.bat:A
## 105  0.000000e+00                   Age.bat:E
```

```
## 106  0.000000e+00                Age.bat:DP
## 107  0.000000e+00              Age.bat:Fld.
## 108  0.000000e+00              Age.bat:RF.9
## 110  0.000000e+00       Age.bat:tot_fa_war3
## 111  0.000000e+00           Age.bat:num_fas
## 112  0.000000e+00                    PA:AB
## 113  0.000000e+00                  PA:H.bat
## 114  0.000000e+00                    PA:X2B
## 115  0.000000e+00                    PA:X3B
## 116  0.000000e+00                  PA:HR.bat
## 117  0.000000e+00                    PA:SB
## 118  0.000000e+00                    PA:CS
## 119  0.000000e+00                  PA:BB.bat
## 120  0.000000e+00                  PA:SO.bat
## 121  0.000000e+00                    PA:BA
## 122  0.000000e+00                   PA:OBP
## 123  0.000000e+00                   PA:SLG
## 124  0.000000e+00                   PA:OPS
## 125  0.000000e+00                 PA:OPSplus
## 126  0.000000e+00                    PA:TB
## 127  0.000000e+00                   PA:GDP
## 128  0.000000e+00                 PA:HBP.bat
## 129  0.000000e+00                    PA:SH
## 130  0.000000e+00                    PA:SF
## 131  0.000000e+00                 PA:IBB.bat
## 132  0.000000e+00               PA:Age.pitch
## 133  0.000000e+00          PA:W.L..same_year
## 134  0.000000e+00                    PA:GF
## 135  0.000000e+00                   PA:SHO
## 136  0.000000e+00                    PA:SV
## 137  0.000000e+00                    PA:IP
## 138  0.000000e+00                 PA:H.pitch
## 139  0.000000e+00                PA:HR.pitch
## 140  0.000000e+00                PA:BB.pitch
## 141  0.000000e+00               PA:IBB.pitch
## 142  0.000000e+00                PA:SO.pitch
## 143  0.000000e+00               PA:HBP.pitch
## 144  0.000000e+00                    PA:BK
## 145  0.000000e+00                    PA:WP
## 146  0.000000e+00                    PA:BF
## 147  0.000000e+00                   PA:FIP
## 148  0.000000e+00                  PA:WHIP
## 149  0.000000e+00                    PA:H9
## 150  0.000000e+00                   PA:HR9
## 151  0.000000e+00                   PA:BB9
## 152  0.000000e+00                   PA:SO9
## 153  0.000000e+00                  PA:SO.W
## 154  0.000000e+00                     PA:G
## 155  0.000000e+00                   PA:Inn
## 156  0.000000e+00                    PA:Ch
## 157  0.000000e+00                    PA:PO
## 158  0.000000e+00                     PA:A
## 159  0.000000e+00                     PA:E
## 160  0.000000e+00                    PA:DP
```

```
## 161  0.000000e+00                  PA:Fld.
## 162  0.000000e+00                  PA:RF.9
## 163  0.000000e+00                  PA:RF.G
## 164  0.000000e+00            PA:tot_fa_war3
## 165  0.000000e+00                PA:num_fas
## 166  0.000000e+00                  AB:H.bat
## 167  0.000000e+00                    AB:X2B
## 168  0.000000e+00                    AB:X3B
## 169  0.000000e+00                  AB:HR.bat
## 170  0.000000e+00                      AB:SB
## 171  0.000000e+00                      AB:CS
## 172  0.000000e+00                  AB:BB.bat
## 173  0.000000e+00                  AB:SO.bat
## 174  0.000000e+00                      AB:BA
## 175  0.000000e+00                     AB:OBP
## 176  0.000000e+00                     AB:SLG
## 177  0.000000e+00                     AB:OPS
## 178  0.000000e+00                AB:OPSplus
## 179  0.000000e+00                      AB:TB
## 180  0.000000e+00                     AB:GDP
## 181  0.000000e+00                 AB:HBP.bat
## 182  0.000000e+00                      AB:SH
## 183  0.000000e+00                      AB:SF
## 184  0.000000e+00                 AB:IBB.bat
## 185  0.000000e+00              AB:Age.pitch
## 186  0.000000e+00          AB:W.L..same_year
## 187  0.000000e+00                      AB:GF
## 188  0.000000e+00                     AB:SHO
## 189  0.000000e+00                      AB:SV
## 190  0.000000e+00                      AB:IP
## 191  0.000000e+00                 AB:H.pitch
## 192  0.000000e+00                AB:HR.pitch
## 193  0.000000e+00                AB:BB.pitch
## 194  0.000000e+00               AB:IBB.pitch
## 195  0.000000e+00                AB:SO.pitch
## 196  0.000000e+00               AB:HBP.pitch
## 197  0.000000e+00                      AB:BK
## 198  0.000000e+00                      AB:WP
## 199  0.000000e+00                      AB:BF
## 200  0.000000e+00                     AB:FIP
## 201  0.000000e+00                    AB:WHIP
## 202  0.000000e+00                      AB:H9
## 204  0.000000e+00                     AB:BB9
## 205  0.000000e+00                     AB:SO9
## 206  0.000000e+00                    AB:SO.W
## 207  0.000000e+00                       AB:G
## 208  0.000000e+00                     AB:Inn
## 209  0.000000e+00                      AB:Ch
## 210  0.000000e+00                      AB:PO
## 211  0.000000e+00                       AB:A
## 212  0.000000e+00                       AB:E
## 213  0.000000e+00                      AB:DP
## 214  0.000000e+00                  AB:Fld.
## 215  0.000000e+00                  AB:RF.9
```

```
## 216  0.000000e+00                  AB:RF.G
## 217  0.000000e+00             AB:tot_fa_war3
## 218  0.000000e+00                 AB:num_fas
## 219  0.000000e+00                  H.bat:X2B
## 220  0.000000e+00                  H.bat:X3B
## 221  0.000000e+00                H.bat:HR.bat
## 222  0.000000e+00                   H.bat:SB
## 223  0.000000e+00                   H.bat:CS
## 224  0.000000e+00                H.bat:BB.bat
## 225  0.000000e+00                H.bat:SO.bat
## 226  0.000000e+00                   H.bat:BA
## 227  0.000000e+00                  H.bat:OBP
## 228  0.000000e+00                  H.bat:SLG
## 229  0.000000e+00                  H.bat:OPS
## 230  0.000000e+00              H.bat:OPSplus
## 231  0.000000e+00                   H.bat:TB
## 232  0.000000e+00                  H.bat:GDP
## 233  0.000000e+00              H.bat:HBP.bat
## 234  0.000000e+00                   H.bat:SH
## 235  0.000000e+00                   H.bat:SF
## 236  0.000000e+00              H.bat:IBB.bat
## 237  0.000000e+00           H.bat:Age.pitch
## 238  0.000000e+00       H.bat:W.L..same_year
## 239  0.000000e+00                   H.bat:GF
## 240  0.000000e+00                  H.bat:SHO
## 241  0.000000e+00                   H.bat:SV
## 242  0.000000e+00                   H.bat:IP
## 243  0.000000e+00              H.bat:H.pitch
## 244  0.000000e+00             H.bat:HR.pitch
## 245  0.000000e+00             H.bat:BB.pitch
## 246  0.000000e+00            H.bat:IBB.pitch
## 247  0.000000e+00             H.bat:SO.pitch
## 248  0.000000e+00            H.bat:HBP.pitch
## 249  0.000000e+00                   H.bat:BK
## 250  0.000000e+00                   H.bat:WP
## 251  0.000000e+00                   H.bat:BF
## 252  0.000000e+00                  H.bat:FIP
## 253  0.000000e+00                 H.bat:WHIP
## 254  0.000000e+00                   H.bat:H9
## 255  0.000000e+00                  H.bat:HR9
## 256  0.000000e+00                  H.bat:BB9
## 257  0.000000e+00                  H.bat:SO9
## 258  0.000000e+00                 H.bat:SO.W
## 259  0.000000e+00                    H.bat:G
## 260  0.000000e+00                  H.bat:Inn
## 261  0.000000e+00                   H.bat:Ch
## 262  0.000000e+00                   H.bat:PO
## 263  0.000000e+00                    H.bat:A
## 264  0.000000e+00                    H.bat:E
## 265  0.000000e+00                   H.bat:DP
## 266  0.000000e+00                 H.bat:Fld.
## 267  0.000000e+00                 H.bat:RF.9
## 268  0.000000e+00                 H.bat:RF.G
## 269  0.000000e+00           H.bat:tot_fa_war3
```

```
## 270  0.000000e+00              H.bat:num_fas
## 271  0.000000e+00                    X2B:X3B
## 272  0.000000e+00                 X2B:HR.bat
## 273  0.000000e+00                     X2B:SB
## 274  0.000000e+00                     X2B:CS
## 275  0.000000e+00                 X2B:BB.bat
## 276  0.000000e+00                 X2B:SO.bat
## 277  0.000000e+00                     X2B:BA
## 278  0.000000e+00                    X2B:OBP
## 279  0.000000e+00                    X2B:SLG
## 280  0.000000e+00                    X2B:OPS
## 281  0.000000e+00                X2B:OPSplus
## 282  0.000000e+00                     X2B:TB
## 283  0.000000e+00                    X2B:GDP
## 284  0.000000e+00                X2B:HBP.bat
## 285  0.000000e+00                     X2B:SH
## 286  0.000000e+00                     X2B:SF
## 287  0.000000e+00                X2B:IBB.bat
## 288  0.000000e+00              X2B:Age.pitch
## 289  0.000000e+00         X2B:W.L..same_year
## 290  0.000000e+00                     X2B:GF
## 291  0.000000e+00                    X2B:SHO
## 292  0.000000e+00                     X2B:SV
## 293  0.000000e+00                     X2B:IP
## 294  0.000000e+00                X2B:H.pitch
## 295  0.000000e+00               X2B:HR.pitch
## 296  0.000000e+00               X2B:BB.pitch
## 297  0.000000e+00              X2B:IBB.pitch
## 298  0.000000e+00               X2B:SO.pitch
## 299  0.000000e+00              X2B:HBP.pitch
## 300  0.000000e+00                     X2B:BK
## 301  0.000000e+00                     X2B:WP
## 302  0.000000e+00                     X2B:BF
## 303  0.000000e+00                    X2B:FIP
## 304  0.000000e+00                   X2B:WHIP
## 305  0.000000e+00                     X2B:H9
## 306  0.000000e+00                    X2B:HR9
## 307  0.000000e+00                    X2B:BB9
## 308  0.000000e+00                    X2B:SO9
## 309  0.000000e+00                   X2B:SO.W
## 310  0.000000e+00                      X2B:G
## 311  0.000000e+00                    X2B:Inn
## 312  0.000000e+00                     X2B:Ch
## 313  0.000000e+00                     X2B:PO
## 314  0.000000e+00                      X2B:A
## 315  0.000000e+00                      X2B:E
## 316  0.000000e+00                     X2B:DP
## 317  0.000000e+00                   X2B:Fld.
## 318  0.000000e+00                   X2B:RF.9
## 319  0.000000e+00                   X2B:RF.G
## 320  0.000000e+00            X2B:tot_fa_war3
## 321  0.000000e+00                X2B:num_fas
## 322  0.000000e+00                 X3B:HR.bat
## 323  0.000000e+00                     X3B:SB
```

```
## 324  0.000000e+00                  X3B:CS
## 325  0.000000e+00               X3B:BB.bat
## 326  0.000000e+00               X3B:SO.bat
## 327  0.000000e+00                  X3B:BA
## 328  0.000000e+00                 X3B:OBP
## 329  0.000000e+00                 X3B:SLG
## 330  0.000000e+00                 X3B:OPS
## 331  0.000000e+00              X3B:OPSplus
## 332  0.000000e+00                  X3B:TB
## 333  0.000000e+00                 X3B:GDP
## 334  0.000000e+00              X3B:HBP.bat
## 335  0.000000e+00                  X3B:SH
## 336  0.000000e+00                  X3B:SF
## 337  0.000000e+00              X3B:IBB.bat
## 338  0.000000e+00           X3B:Age.pitch
## 339  0.000000e+00      X3B:W.L..same_year
## 340  0.000000e+00                  X3B:GF
## 341  0.000000e+00                 X3B:SHO
## 342  0.000000e+00                  X3B:SV
## 343  0.000000e+00                  X3B:IP
## 344  0.000000e+00              X3B:H.pitch
## 345  0.000000e+00             X3B:HR.pitch
## 346  0.000000e+00             X3B:BB.pitch
## 347  0.000000e+00            X3B:IBB.pitch
## 348  0.000000e+00             X3B:SO.pitch
## 349  0.000000e+00            X3B:HBP.pitch
## 350  0.000000e+00                  X3B:BK
## 351  0.000000e+00                  X3B:WP
## 352  0.000000e+00                  X3B:BF
## 353  0.000000e+00                 X3B:FIP
## 354  0.000000e+00                X3B:WHIP
## 355  0.000000e+00                  X3B:H9
## 357  0.000000e+00                 X3B:BB9
## 358  0.000000e+00                 X3B:SO9
## 359  0.000000e+00                X3B:SO.W
## 360  0.000000e+00                   X3B:G
## 361  0.000000e+00                 X3B:Inn
## 362  0.000000e+00                  X3B:Ch
## 363  0.000000e+00                  X3B:PO
## 364  0.000000e+00                   X3B:A
## 365  0.000000e+00                   X3B:E
## 366  0.000000e+00                  X3B:DP
## 367  0.000000e+00                X3B:Fld.
## 368  0.000000e+00                X3B:RF.9
## 369  0.000000e+00                X3B:RF.G
## 370  0.000000e+00          X3B:tot_fa_war3
## 371  0.000000e+00              X3B:num_fas
## 372  0.000000e+00                HR.bat:SB
## 373  0.000000e+00                HR.bat:CS
## 374  0.000000e+00             HR.bat:BB.bat
## 375  0.000000e+00             HR.bat:SO.bat
## 376  0.000000e+00                 HR.bat:BA
## 377  0.000000e+00                HR.bat:OBP
## 378  0.000000e+00                HR.bat:SLG
```

```
## 379  0.000000e+00                HR.bat:OPS
## 380  0.000000e+00            HR.bat:OPSplus
## 381  0.000000e+00                 HR.bat:TB
## 382  0.000000e+00                HR.bat:GDP
## 383  0.000000e+00            HR.bat:HBP.bat
## 384  0.000000e+00                 HR.bat:SH
## 385  0.000000e+00                 HR.bat:SF
## 387  0.000000e+00          HR.bat:Age.pitch
## 388  0.000000e+00     HR.bat:W.L..same_year
## 389  0.000000e+00                 HR.bat:GF
## 390  0.000000e+00                HR.bat:SHO
## 392  0.000000e+00                 HR.bat:IP
## 393  0.000000e+00            HR.bat:H.pitch
## 394  0.000000e+00           HR.bat:HR.pitch
## 395  0.000000e+00           HR.bat:BB.pitch
## 397  0.000000e+00           HR.bat:SO.pitch
## 398  0.000000e+00          HR.bat:HBP.pitch
## 399  0.000000e+00                 HR.bat:BK
## 400  0.000000e+00                 HR.bat:WP
## 401  0.000000e+00                 HR.bat:BF
## 402  0.000000e+00                HR.bat:FIP
## 403  0.000000e+00               HR.bat:WHIP
## 404  0.000000e+00                 HR.bat:H9
## 405  0.000000e+00                HR.bat:HR9
## 406  0.000000e+00                HR.bat:BB9
## 407  0.000000e+00                HR.bat:SO9
## 409  0.000000e+00                  HR.bat:G
## 410  0.000000e+00                HR.bat:Inn
## 411  0.000000e+00                 HR.bat:Ch
## 412  0.000000e+00                 HR.bat:PO
## 413  0.000000e+00                  HR.bat:A
## 415  0.000000e+00                 HR.bat:DP
## 416  0.000000e+00               HR.bat:Fld.
## 417  0.000000e+00               HR.bat:RF.9
## 418  0.000000e+00               HR.bat:RF.G
## 419  0.000000e+00        HR.bat:tot_fa_war3
## 420  0.000000e+00            HR.bat:num_fas
## 421  0.000000e+00                    SB:CS
## 422  0.000000e+00                 SB:BB.bat
## 423  0.000000e+00                 SB:SO.bat
## 424  0.000000e+00                     SB:BA
## 425  0.000000e+00                    SB:OBP
## 426  0.000000e+00                    SB:SLG
## 427  0.000000e+00                    SB:OPS
## 428  0.000000e+00                SB:OPSplus
## 429  0.000000e+00                     SB:TB
## 430  0.000000e+00                    SB:GDP
## 431  0.000000e+00                SB:HBP.bat
## 432  0.000000e+00                     SB:SH
## 433  0.000000e+00                     SB:SF
## 434  0.000000e+00                SB:IBB.bat
## 435  0.000000e+00              SB:Age.pitch
## 436  0.000000e+00         SB:W.L..same_year
## 437  0.000000e+00                     SB:GF
```

```
## 438  0.000000e+00                  SB:SHO
## 439  0.000000e+00                   SB:SV
## 440  0.000000e+00                   SB:IP
## 441  0.000000e+00                SB:H.pitch
## 442  0.000000e+00               SB:HR.pitch
## 443  0.000000e+00               SB:BB.pitch
## 444  0.000000e+00              SB:IBB.pitch
## 445  0.000000e+00               SB:SO.pitch
## 446  0.000000e+00              SB:HBP.pitch
## 447  0.000000e+00                   SB:BK
## 448  0.000000e+00                   SB:WP
## 449  0.000000e+00                   SB:BF
## 450  0.000000e+00                  SB:FIP
## 451  0.000000e+00                 SB:WHIP
## 452  0.000000e+00                   SB:H9
## 453  0.000000e+00                  SB:HR9
## 454  0.000000e+00                  SB:BB9
## 455  0.000000e+00                  SB:SO9
## 456  0.000000e+00                 SB:SO.W
## 457  0.000000e+00                    SB:G
## 458  0.000000e+00                  SB:Inn
## 459  0.000000e+00                   SB:Ch
## 460  0.000000e+00                   SB:PO
## 461  0.000000e+00                    SB:A
## 462  0.000000e+00                    SB:E
## 463  0.000000e+00                   SB:DP
## 464  0.000000e+00                 SB:Fld.
## 465  0.000000e+00                 SB:RF.9
## 466  0.000000e+00                 SB:RF.G
## 467  0.000000e+00            SB:tot_fa_war3
## 468  0.000000e+00                SB:num_fas
## 469  0.000000e+00                CS:BB.bat
## 470  0.000000e+00                CS:SO.bat
## 471  0.000000e+00                    CS:BA
## 472  0.000000e+00                   CS:OBP
## 473  0.000000e+00                   CS:SLG
## 474  0.000000e+00                   CS:OPS
## 475  0.000000e+00               CS:OPSplus
## 476  0.000000e+00                    CS:TB
## 477  0.000000e+00                   CS:GDP
## 478  0.000000e+00               CS:HBP.bat
## 479  0.000000e+00                    CS:SH
## 480  0.000000e+00                    CS:SF
## 481  0.000000e+00               CS:IBB.bat
## 482  0.000000e+00             CS:Age.pitch
## 483  0.000000e+00         CS:W.L..same_year
## 484  0.000000e+00                    CS:GF
## 485  0.000000e+00                  CS:SHO
## 486  0.000000e+00                   CS:SV
## 487  0.000000e+00                   CS:IP
## 488  0.000000e+00                CS:H.pitch
## 489  0.000000e+00               CS:HR.pitch
## 490  0.000000e+00               CS:BB.pitch
## 491  0.000000e+00              CS:IBB.pitch
```

```
## 492  0.000000e+00               CS:SO.pitch
## 493  0.000000e+00              CS:HBP.pitch
## 494  0.000000e+00                     CS:BK
## 495  0.000000e+00                     CS:WP
## 496  0.000000e+00                     CS:BF
## 497  0.000000e+00                    CS:FIP
## 498  0.000000e+00                   CS:WHIP
## 499  0.000000e+00                     CS:H9
## 500  0.000000e+00                    CS:HR9
## 501  0.000000e+00                    CS:BB9
## 502  0.000000e+00                    CS:SO9
## 503  0.000000e+00                   CS:SO.W
## 504  0.000000e+00                      CS:G
## 505  0.000000e+00                    CS:Inn
## 506  0.000000e+00                     CS:Ch
## 507  0.000000e+00                     CS:PO
## 508  0.000000e+00                      CS:A
## 509  0.000000e+00                      CS:E
## 510  0.000000e+00                     CS:DP
## 511  0.000000e+00                   CS:Fld.
## 512  0.000000e+00                   CS:RF.9
## 513  0.000000e+00                   CS:RF.G
## 514  0.000000e+00            CS:tot_fa_war3
## 515  0.000000e+00                CS:num_fas
## 516  0.000000e+00             BB.bat:SO.bat
## 517  0.000000e+00                 BB.bat:BA
## 518  0.000000e+00                BB.bat:OBP
## 519  0.000000e+00                BB.bat:SLG
## 520  0.000000e+00                BB.bat:OPS
## 521  0.000000e+00            BB.bat:OPSplus
## 522  0.000000e+00                 BB.bat:TB
## 523  0.000000e+00                BB.bat:GDP
## 524  0.000000e+00            BB.bat:HBP.bat
## 525  0.000000e+00                 BB.bat:SH
## 526  0.000000e+00                 BB.bat:SF
## 527  0.000000e+00            BB.bat:IBB.bat
## 529  0.000000e+00     BB.bat:W.L..same_year
## 530  0.000000e+00                 BB.bat:GF
## 531  0.000000e+00               BB.bat:SHO
## 533  0.000000e+00                 BB.bat:IP
## 534  0.000000e+00            BB.bat:H.pitch
## 535  0.000000e+00           BB.bat:HR.pitch
## 536  0.000000e+00           BB.bat:BB.pitch
## 537  0.000000e+00          BB.bat:IBB.pitch
## 538  0.000000e+00           BB.bat:SO.pitch
## 539  0.000000e+00          BB.bat:HBP.pitch
## 540  0.000000e+00                 BB.bat:BK
## 541  0.000000e+00                 BB.bat:WP
## 542  0.000000e+00                 BB.bat:BF
## 543  0.000000e+00               BB.bat:FIP
## 544  0.000000e+00              BB.bat:WHIP
## 545  0.000000e+00                BB.bat:H9
## 546  0.000000e+00               BB.bat:HR9
## 547  0.000000e+00               BB.bat:BB9
```

```
## 549  0.000000e+00               BB.bat:SO.W
## 550  0.000000e+00                  BB.bat:G
## 551  0.000000e+00                BB.bat:Inn
## 552  0.000000e+00                 BB.bat:Ch
## 553  0.000000e+00                 BB.bat:PO
## 554  0.000000e+00                  BB.bat:A
## 556  0.000000e+00                 BB.bat:DP
## 557  0.000000e+00               BB.bat:Fld.
## 558  0.000000e+00               BB.bat:RF.9
## 559  0.000000e+00               BB.bat:RF.G
## 560  0.000000e+00        BB.bat:tot_fa_war3
## 561  0.000000e+00            BB.bat:num_fas
## 562  0.000000e+00                 SO.bat:BA
## 563  0.000000e+00                SO.bat:OBP
## 564  0.000000e+00                SO.bat:SLG
## 565  0.000000e+00                SO.bat:OPS
## 566  0.000000e+00            SO.bat:OPSplus
## 567  0.000000e+00                 SO.bat:TB
## 569  0.000000e+00            SO.bat:HBP.bat
## 570  0.000000e+00                 SO.bat:SH
## 571  0.000000e+00                 SO.bat:SF
## 572  0.000000e+00            SO.bat:IBB.bat
## 573  0.000000e+00          SO.bat:Age.pitch
## 574  0.000000e+00     SO.bat:W.L..same_year
## 575  0.000000e+00                 SO.bat:GF
## 576  0.000000e+00               SO.bat:SHO
## 577  0.000000e+00                 SO.bat:SV
## 578  0.000000e+00                 SO.bat:IP
## 579  0.000000e+00            SO.bat:H.pitch
## 581  0.000000e+00           SO.bat:BB.pitch
## 582  0.000000e+00          SO.bat:IBB.pitch
## 583  0.000000e+00           SO.bat:SO.pitch
## 584  0.000000e+00          SO.bat:HBP.pitch
## 585  0.000000e+00                 SO.bat:BK
## 586  0.000000e+00                 SO.bat:WP
## 587  0.000000e+00                 SO.bat:BF
## 589  0.000000e+00               SO.bat:WHIP
## 590  0.000000e+00                 SO.bat:H9
## 592  0.000000e+00                SO.bat:BB9
## 593  0.000000e+00                SO.bat:SO9
## 594  0.000000e+00               SO.bat:SO.W
## 595  0.000000e+00                  SO.bat:G
## 596  0.000000e+00                SO.bat:Inn
## 597  0.000000e+00                 SO.bat:Ch
## 598  0.000000e+00                 SO.bat:PO
## 599  0.000000e+00                  SO.bat:A
## 600  0.000000e+00                  SO.bat:E
## 601  0.000000e+00                 SO.bat:DP
## 602  0.000000e+00               SO.bat:Fld.
## 603  0.000000e+00               SO.bat:RF.9
## 604  0.000000e+00               SO.bat:RF.G
## 605  0.000000e+00        SO.bat:tot_fa_war3
## 607  0.000000e+00                   BA:OBP
## 608  0.000000e+00                   BA:SLG
```

```
## 609  0.000000e+00                  BA:OPS
## 610  0.000000e+00                BA:OPSplus
## 611  0.000000e+00                     BA:TB
## 612  0.000000e+00                    BA:GDP
## 613  0.000000e+00                BA:HBP.bat
## 614  0.000000e+00                     BA:SH
## 615  0.000000e+00                     BA:SF
## 616  0.000000e+00                BA:IBB.bat
## 617  0.000000e+00             BA:Age.pitch
## 618  0.000000e+00          BA:W.L..same_year
## 619  0.000000e+00                    BA:GF
## 620  0.000000e+00                   BA:SHO
## 621  0.000000e+00                    BA:SV
## 622  0.000000e+00                    BA:IP
## 623  0.000000e+00                 BA:H.pitch
## 624  0.000000e+00                BA:HR.pitch
## 625  0.000000e+00                BA:BB.pitch
## 626  0.000000e+00               BA:IBB.pitch
## 627  0.000000e+00                BA:SO.pitch
## 628  0.000000e+00               BA:HBP.pitch
## 629  0.000000e+00                    BA:BK
## 630  0.000000e+00                    BA:WP
## 631  0.000000e+00                    BA:BF
## 632  0.000000e+00                   BA:FIP
## 633  0.000000e+00                  BA:WHIP
## 634  0.000000e+00                    BA:H9
## 635  0.000000e+00                   BA:HR9
## 636  0.000000e+00                   BA:BB9
## 637  0.000000e+00                   BA:SO9
## 638  0.000000e+00                  BA:SO.W
## 639  0.000000e+00                     BA:G
## 640  0.000000e+00                   BA:Inn
## 641  0.000000e+00                    BA:Ch
## 642  0.000000e+00                    BA:PO
## 643  0.000000e+00                     BA:A
## 644  0.000000e+00                     BA:E
## 645  0.000000e+00                    BA:DP
## 646  0.000000e+00                  BA:Fld.
## 647  0.000000e+00                  BA:RF.9
## 648  0.000000e+00                  BA:RF.G
## 649  0.000000e+00             BA:tot_fa_war3
## 650  0.000000e+00                 BA:num_fas
## 651  0.000000e+00                    OBP:SLG
## 652  0.000000e+00                    OBP:OPS
## 653  0.000000e+00                OBP:OPSplus
## 654  0.000000e+00                     OBP:TB
## 655  0.000000e+00                    OBP:GDP
## 656  0.000000e+00                OBP:HBP.bat
## 657  0.000000e+00                     OBP:SH
## 658  0.000000e+00                     OBP:SF
## 659  0.000000e+00                OBP:IBB.bat
## 661  0.000000e+00          OBP:W.L..same_year
## 662  0.000000e+00                    OBP:GF
## 663  0.000000e+00                   OBP:SHO
```

```
## 664  0.000000e+00                  OBP:SV
## 665  0.000000e+00                  OBP:IP
## 666  0.000000e+00               OBP:H.pitch
## 667  0.000000e+00              OBP:HR.pitch
## 668  0.000000e+00              OBP:BB.pitch
## 669  0.000000e+00             OBP:IBB.pitch
## 670  0.000000e+00              OBP:SO.pitch
## 671  0.000000e+00             OBP:HBP.pitch
## 672  0.000000e+00                    OBP:BK
## 673  0.000000e+00                    OBP:WP
## 674  0.000000e+00                    OBP:BF
## 675  0.000000e+00                   OBP:FIP
## 676  0.000000e+00                  OBP:WHIP
## 677  0.000000e+00                    OBP:H9
## 678  0.000000e+00                   OBP:HR9
## 679  0.000000e+00                   OBP:BB9
## 680  0.000000e+00                   OBP:SO9
## 681  0.000000e+00                  OBP:SO.W
## 682  0.000000e+00                     OBP:G
## 683  0.000000e+00                   OBP:Inn
## 684  0.000000e+00                    OBP:Ch
## 685  0.000000e+00                    OBP:PO
## 686  0.000000e+00                     OBP:A
## 687  0.000000e+00                     OBP:E
## 688  0.000000e+00                    OBP:DP
## 689  0.000000e+00                  OBP:Fld.
## 690  0.000000e+00                  OBP:RF.9
## 691  0.000000e+00                  OBP:RF.G
## 692  0.000000e+00            OBP:tot_fa_war3
## 693  0.000000e+00                OBP:num_fas
## 694  0.000000e+00                    SLG:OPS
## 695  0.000000e+00               SLG:OPSplus
## 696  0.000000e+00                    SLG:TB
## 697  0.000000e+00                   SLG:GDP
## 698  0.000000e+00               SLG:HBP.bat
## 699  0.000000e+00                    SLG:SH
## 700  0.000000e+00                    SLG:SF
## 701  0.000000e+00               SLG:IBB.bat
## 702  0.000000e+00            SLG:Age.pitch
## 703  0.000000e+00         SLG:W.L..same_year
## 704  0.000000e+00                    SLG:GF
## 705  0.000000e+00                   SLG:SHO
## 706  0.000000e+00                    SLG:SV
## 707  0.000000e+00                    SLG:IP
## 708  0.000000e+00               SLG:H.pitch
## 709  0.000000e+00              SLG:HR.pitch
## 710  0.000000e+00              SLG:BB.pitch
## 711  0.000000e+00             SLG:IBB.pitch
## 712  0.000000e+00              SLG:SO.pitch
## 713  0.000000e+00             SLG:HBP.pitch
## 714  0.000000e+00                    SLG:BK
## 715  0.000000e+00                    SLG:WP
## 716  0.000000e+00                    SLG:BF
## 717  0.000000e+00                   SLG:FIP
```

```
## 718  0.000000e+00                 SLG:WHIP
## 719  0.000000e+00                   SLG:H9
## 720  0.000000e+00                  SLG:HR9
## 721  0.000000e+00                  SLG:BB9
## 722  0.000000e+00                  SLG:SO9
## 723  0.000000e+00                 SLG:SO.W
## 724  0.000000e+00                    SLG:G
## 725  0.000000e+00                  SLG:Inn
## 726  0.000000e+00                   SLG:Ch
## 727  0.000000e+00                   SLG:PO
## 728  0.000000e+00                    SLG:A
## 729  0.000000e+00                    SLG:E
## 730  0.000000e+00                   SLG:DP
## 731  0.000000e+00                 SLG:Fld.
## 732  0.000000e+00                 SLG:RF.9
## 733  0.000000e+00                 SLG:RF.G
## 734  0.000000e+00           SLG:tot_fa_war3
## 735  0.000000e+00               SLG:num_fas
## 736  0.000000e+00               OPS:OPSplus
## 737  0.000000e+00                    OPS:TB
## 738  0.000000e+00                   OPS:GDP
## 739  0.000000e+00               OPS:HBP.bat
## 740  0.000000e+00                    OPS:SH
## 741  0.000000e+00                    OPS:SF
## 742  0.000000e+00               OPS:IBB.bat
## 743  0.000000e+00             OPS:Age.pitch
## 744  0.000000e+00        OPS:W.L..same_year
## 745  0.000000e+00                    OPS:GF
## 746  0.000000e+00                   OPS:SHO
## 747  0.000000e+00                    OPS:SV
## 748  0.000000e+00                    OPS:IP
## 749  0.000000e+00               OPS:H.pitch
## 750  0.000000e+00              OPS:HR.pitch
## 751  0.000000e+00              OPS:BB.pitch
## 752  0.000000e+00             OPS:IBB.pitch
## 753  0.000000e+00              OPS:SO.pitch
## 754  0.000000e+00             OPS:HBP.pitch
## 755  0.000000e+00                    OPS:BK
## 756  0.000000e+00                    OPS:WP
## 757  0.000000e+00                    OPS:BF
## 758  0.000000e+00                   OPS:FIP
## 759  0.000000e+00                  OPS:WHIP
## 760  0.000000e+00                    OPS:H9
## 761  0.000000e+00                   OPS:HR9
## 762  0.000000e+00                   OPS:BB9
## 763  0.000000e+00                   OPS:SO9
## 764  0.000000e+00                  OPS:SO.W
## 765  0.000000e+00                     OPS:G
## 766  0.000000e+00                   OPS:Inn
## 767  0.000000e+00                    OPS:Ch
## 768  0.000000e+00                    OPS:PO
## 769  0.000000e+00                     OPS:A
## 770  0.000000e+00                     OPS:E
## 771  0.000000e+00                    OPS:DP
```

```
## 772  0.000000e+00                 OPS:Fld.
## 773  0.000000e+00                 OPS:RF.9
## 774  0.000000e+00                 OPS:RF.G
## 775  0.000000e+00           OPS:tot_fa_war3
## 776  0.000000e+00               OPS:num_fas
## 777  0.000000e+00                OPSplus:TB
## 778  0.000000e+00               OPSplus:GDP
## 779  0.000000e+00           OPSplus:HBP.bat
## 780  0.000000e+00                OPSplus:SH
## 781  0.000000e+00                OPSplus:SF
## 782  0.000000e+00           OPSplus:IBB.bat
## 783  0.000000e+00         OPSplus:Age.pitch
## 784  0.000000e+00    OPSplus:W.L..same_year
## 785  0.000000e+00               OPSplus:GF
## 786  0.000000e+00              OPSplus:SHO
## 787  0.000000e+00               OPSplus:SV
## 788  0.000000e+00               OPSplus:IP
## 789  0.000000e+00           OPSplus:H.pitch
## 790  0.000000e+00          OPSplus:HR.pitch
## 791  0.000000e+00          OPSplus:BB.pitch
## 792  0.000000e+00         OPSplus:IBB.pitch
## 793  0.000000e+00          OPSplus:SO.pitch
## 794  0.000000e+00         OPSplus:HBP.pitch
## 795  0.000000e+00                OPSplus:BK
## 796  0.000000e+00                OPSplus:WP
## 797  0.000000e+00                OPSplus:BF
## 798  0.000000e+00               OPSplus:FIP
## 799  0.000000e+00              OPSplus:WHIP
## 800  0.000000e+00                OPSplus:H9
## 801  0.000000e+00               OPSplus:HR9
## 802  0.000000e+00               OPSplus:BB9
## 803  0.000000e+00               OPSplus:SO9
## 804  0.000000e+00              OPSplus:SO.W
## 805  0.000000e+00                 OPSplus:G
## 806  0.000000e+00               OPSplus:Inn
## 807  0.000000e+00                OPSplus:Ch
## 808  0.000000e+00                OPSplus:PO
## 809  0.000000e+00                 OPSplus:A
## 810  0.000000e+00                 OPSplus:E
## 811  0.000000e+00                OPSplus:DP
## 812  0.000000e+00              OPSplus:Fld.
## 813  0.000000e+00              OPSplus:RF.9
## 814  0.000000e+00              OPSplus:RF.G
## 815  0.000000e+00       OPSplus:tot_fa_war3
## 816  0.000000e+00           OPSplus:num_fas
## 817  0.000000e+00                    TB:GDP
## 818  0.000000e+00                TB:HBP.bat
## 819  0.000000e+00                     TB:SH
## 820  0.000000e+00                     TB:SF
## 821  0.000000e+00                TB:IBB.bat
## 822  0.000000e+00              TB:Age.pitch
## 823  0.000000e+00         TB:W.L..same_year
## 824  0.000000e+00                    TB:GF
## 825  0.000000e+00                   TB:SHO
```

```
## 826  0.000000e+00                  TB:SV
## 827  0.000000e+00                  TB:IP
## 828  0.000000e+00               TB:H.pitch
## 829  0.000000e+00              TB:HR.pitch
## 830  0.000000e+00              TB:BB.pitch
## 831  0.000000e+00             TB:IBB.pitch
## 832  0.000000e+00              TB:SO.pitch
## 833  0.000000e+00             TB:HBP.pitch
## 834  0.000000e+00                  TB:BK
## 835  0.000000e+00                  TB:WP
## 836  0.000000e+00                  TB:BF
## 837  0.000000e+00                 TB:FIP
## 838  0.000000e+00                TB:WHIP
## 839  0.000000e+00                  TB:H9
## 840  0.000000e+00                 TB:HR9
## 841  0.000000e+00                 TB:BB9
## 842  0.000000e+00                 TB:SO9
## 843  0.000000e+00                TB:SO.W
## 844  0.000000e+00                   TB:G
## 845  0.000000e+00                 TB:Inn
## 846  0.000000e+00                  TB:Ch
## 847  0.000000e+00                  TB:PO
## 848  0.000000e+00                   TB:A
## 849  0.000000e+00                   TB:E
## 850  0.000000e+00                  TB:DP
## 851  0.000000e+00                TB:Fld.
## 852  0.000000e+00                TB:RF.9
## 853  0.000000e+00                TB:RF.G
## 854  0.000000e+00            TB:tot_fa_war3
## 855  0.000000e+00                TB:num_fas
## 856  0.000000e+00              GDP:HBP.bat
## 857  0.000000e+00                   GDP:SH
## 858  0.000000e+00                   GDP:SF
## 859  0.000000e+00              GDP:IBB.bat
## 860  0.000000e+00            GDP:Age.pitch
## 861  0.000000e+00        GDP:W.L..same_year
## 862  0.000000e+00                   GDP:GF
## 863  0.000000e+00                  GDP:SHO
## 864  0.000000e+00                   GDP:SV
## 865  0.000000e+00                   GDP:IP
## 866  0.000000e+00              GDP:H.pitch
## 867  0.000000e+00             GDP:HR.pitch
## 868  0.000000e+00             GDP:BB.pitch
## 869  0.000000e+00            GDP:IBB.pitch
## 870  0.000000e+00             GDP:SO.pitch
## 871  0.000000e+00            GDP:HBP.pitch
## 872  0.000000e+00                   GDP:BK
## 873  0.000000e+00                   GDP:WP
## 874  0.000000e+00                   GDP:BF
## 875  0.000000e+00                  GDP:FIP
## 876  0.000000e+00                 GDP:WHIP
## 877  0.000000e+00                   GDP:H9
## 878  0.000000e+00                  GDP:HR9
## 879  0.000000e+00                  GDP:BB9
```

```
## 880  0.000000e+00                  GDP:SO9
## 881  0.000000e+00                 GDP:SO.W
## 882  0.000000e+00                    GDP:G
## 883  0.000000e+00                  GDP:Inn
## 884  0.000000e+00                   GDP:Ch
## 885  0.000000e+00                   GDP:PO
## 886  0.000000e+00                    GDP:A
## 887  0.000000e+00                    GDP:E
## 888  0.000000e+00                   GDP:DP
## 889  0.000000e+00                 GDP:Fld.
## 890  0.000000e+00                 GDP:RF.9
## 891  0.000000e+00                 GDP:RF.G
## 892  0.000000e+00           GDP:tot_fa_war3
## 894  0.000000e+00                HBP.bat:SH
## 895  0.000000e+00                HBP.bat:SF
## 896  0.000000e+00           HBP.bat:IBB.bat
## 897  0.000000e+00         HBP.bat:Age.pitch
## 898  0.000000e+00     HBP.bat:W.L..same_year
## 899  0.000000e+00                HBP.bat:GF
## 900  0.000000e+00               HBP.bat:SHO
## 901  0.000000e+00                HBP.bat:SV
## 902  0.000000e+00                HBP.bat:IP
## 903  0.000000e+00           HBP.bat:H.pitch
## 904  0.000000e+00          HBP.bat:HR.pitch
## 905  0.000000e+00          HBP.bat:BB.pitch
## 906  0.000000e+00         HBP.bat:IBB.pitch
## 907  0.000000e+00          HBP.bat:SO.pitch
## 908  0.000000e+00         HBP.bat:HBP.pitch
## 909  0.000000e+00                HBP.bat:BK
## 910  0.000000e+00                HBP.bat:WP
## 911  0.000000e+00                HBP.bat:BF
## 912  0.000000e+00               HBP.bat:FIP
## 913  0.000000e+00              HBP.bat:WHIP
## 914  0.000000e+00                HBP.bat:H9
## 915  0.000000e+00               HBP.bat:HR9
## 916  0.000000e+00               HBP.bat:BB9
## 917  0.000000e+00               HBP.bat:SO9
## 918  0.000000e+00              HBP.bat:SO.W
## 919  0.000000e+00                 HBP.bat:G
## 920  0.000000e+00               HBP.bat:Inn
## 921  0.000000e+00                HBP.bat:Ch
## 922  0.000000e+00                HBP.bat:PO
## 923  0.000000e+00                 HBP.bat:A
## 924  0.000000e+00                 HBP.bat:E
## 925  0.000000e+00                HBP.bat:DP
## 926  0.000000e+00              HBP.bat:Fld.
## 927  0.000000e+00              HBP.bat:RF.9
## 928  0.000000e+00              HBP.bat:RF.G
## 929  0.000000e+00       HBP.bat:tot_fa_war3
## 930  0.000000e+00           HBP.bat:num_fas
## 931  0.000000e+00                     SH:SF
## 932  0.000000e+00                SH:IBB.bat
## 933  0.000000e+00              SH:Age.pitch
## 934  0.000000e+00          SH:W.L..same_year
```

```
## 935  0.000000e+00                  SH:GF
## 937  0.000000e+00                  SH:SV
## 938  0.000000e+00                  SH:IP
## 939  0.000000e+00               SH:H.pitch
## 940  0.000000e+00              SH:HR.pitch
## 941  0.000000e+00              SH:BB.pitch
## 942  0.000000e+00             SH:IBB.pitch
## 943  0.000000e+00              SH:SO.pitch
## 944  0.000000e+00             SH:HBP.pitch
## 945  0.000000e+00                  SH:BK
## 946  0.000000e+00                  SH:WP
## 947  0.000000e+00                  SH:BF
## 948  0.000000e+00                 SH:FIP
## 949  0.000000e+00                SH:WHIP
## 950  0.000000e+00                  SH:H9
## 951  0.000000e+00                 SH:HR9
## 952  0.000000e+00                 SH:BB9
## 953  0.000000e+00                 SH:SO9
## 954  0.000000e+00                SH:SO.W
## 955  0.000000e+00                   SH:G
## 956  0.000000e+00                 SH:Inn
## 957  0.000000e+00                  SH:Ch
## 958  0.000000e+00                  SH:PO
## 959  0.000000e+00                   SH:A
## 960  0.000000e+00                   SH:E
## 961  0.000000e+00                  SH:DP
## 962  0.000000e+00                SH:Fld.
## 963  0.000000e+00                SH:RF.9
## 964  0.000000e+00                SH:RF.G
## 965  0.000000e+00           SH:tot_fa_war3
## 966  0.000000e+00               SH:num_fas
## 967  0.000000e+00               SF:IBB.bat
## 968  0.000000e+00             SF:Age.pitch
## 969  0.000000e+00        SF:W.L..same_year
## 970  0.000000e+00                  SF:GF
## 971  0.000000e+00                 SF:SHO
## 972  0.000000e+00                  SF:SV
## 973  0.000000e+00                  SF:IP
## 974  0.000000e+00               SF:H.pitch
## 975  0.000000e+00              SF:HR.pitch
## 976  0.000000e+00              SF:BB.pitch
## 977  0.000000e+00             SF:IBB.pitch
## 978  0.000000e+00              SF:SO.pitch
## 979  0.000000e+00             SF:HBP.pitch
## 980  0.000000e+00                  SF:BK
## 981  0.000000e+00                  SF:WP
## 982  0.000000e+00                  SF:BF
## 983  0.000000e+00                 SF:FIP
## 984  0.000000e+00                SF:WHIP
## 985  0.000000e+00                  SF:H9
## 986  0.000000e+00                 SF:HR9
## 987  0.000000e+00                 SF:BB9
## 988  0.000000e+00                 SF:SO9
## 989  0.000000e+00                SF:SO.W
```

```
## 990  0.000000e+00                    SF:G
## 991  0.000000e+00                  SF:Inn
## 992  0.000000e+00                   SF:Ch
## 993  0.000000e+00                   SF:PO
## 994  0.000000e+00                    SF:A
## 995  0.000000e+00                    SF:E
## 996  0.000000e+00                   SF:DP
## 997  0.000000e+00                  SF:Fld.
## 998  0.000000e+00                  SF:RF.9
## 999  0.000000e+00                  SF:RF.G
## 1000 0.000000e+00           SF:tot_fa_war3
## 1001 0.000000e+00               SF:num_fas
## 1002 0.000000e+00        IBB.bat:Age.pitch
## 1003 0.000000e+00    IBB.bat:W.L..same_year
## 1004 0.000000e+00             IBB.bat:GF
## 1005 0.000000e+00            IBB.bat:SHO
## 1006 0.000000e+00             IBB.bat:SV
## 1007 0.000000e+00             IBB.bat:IP
## 1008 0.000000e+00          IBB.bat:H.pitch
## 1009 0.000000e+00         IBB.bat:HR.pitch
## 1010 0.000000e+00         IBB.bat:BB.pitch
## 1011 0.000000e+00        IBB.bat:IBB.pitch
## 1013 0.000000e+00        IBB.bat:HBP.pitch
## 1014 0.000000e+00             IBB.bat:BK
## 1015 0.000000e+00             IBB.bat:WP
## 1016 0.000000e+00             IBB.bat:BF
## 1017 0.000000e+00            IBB.bat:FIP
## 1018 0.000000e+00           IBB.bat:WHIP
## 1019 0.000000e+00             IBB.bat:H9
## 1020 0.000000e+00            IBB.bat:HR9
## 1021 0.000000e+00            IBB.bat:BB9
## 1022 0.000000e+00            IBB.bat:SO9
## 1023 0.000000e+00           IBB.bat:SO.W
## 1024 0.000000e+00              IBB.bat:G
## 1025 0.000000e+00            IBB.bat:Inn
## 1026 0.000000e+00             IBB.bat:Ch
## 1027 0.000000e+00             IBB.bat:PO
## 1028 0.000000e+00              IBB.bat:A
## 1029 0.000000e+00              IBB.bat:E
## 1030 0.000000e+00             IBB.bat:DP
## 1031 0.000000e+00           IBB.bat:Fld.
## 1032 0.000000e+00           IBB.bat:RF.9
## 1033 0.000000e+00           IBB.bat:RF.G
## 1034 0.000000e+00      IBB.bat:tot_fa_war3
## 1035 0.000000e+00          IBB.bat:num_fas
## 1037 0.000000e+00             Age.pitch:GF
## 1038 0.000000e+00            Age.pitch:SHO
## 1039 0.000000e+00             Age.pitch:SV
## 1040 0.000000e+00             Age.pitch:IP
## 1041 0.000000e+00          Age.pitch:H.pitch
## 1042 0.000000e+00         Age.pitch:HR.pitch
## 1043 0.000000e+00         Age.pitch:BB.pitch
## 1044 0.000000e+00        Age.pitch:IBB.pitch
## 1045 0.000000e+00         Age.pitch:SO.pitch
```

```
## 1046 0.000000e+00        Age.pitch:HBP.pitch
## 1047 0.000000e+00              Age.pitch:BK
## 1048 0.000000e+00              Age.pitch:WP
## 1049 0.000000e+00              Age.pitch:BF
## 1050 0.000000e+00             Age.pitch:FIP
## 1051 0.000000e+00            Age.pitch:WHIP
## 1052 0.000000e+00              Age.pitch:H9
## 1053 0.000000e+00             Age.pitch:HR9
## 1054 0.000000e+00             Age.pitch:BB9
## 1055 0.000000e+00             Age.pitch:SO9
## 1056 0.000000e+00            Age.pitch:SO.W
## 1057 0.000000e+00               Age.pitch:G
## 1058 0.000000e+00             Age.pitch:Inn
## 1059 0.000000e+00              Age.pitch:Ch
## 1060 0.000000e+00              Age.pitch:PO
## 1061 0.000000e+00               Age.pitch:A
## 1062 0.000000e+00               Age.pitch:E
## 1063 0.000000e+00              Age.pitch:DP
## 1064 0.000000e+00            Age.pitch:Fld.
## 1065 0.000000e+00            Age.pitch:RF.9
## 1066 0.000000e+00            Age.pitch:RF.G
## 1067 0.000000e+00      Age.pitch:tot_fa_war3
## 1068 0.000000e+00          Age.pitch:num_fas
## 1069 0.000000e+00          W.L..same_year:GF
## 1070 0.000000e+00         W.L..same_year:SHO
## 1071 0.000000e+00          W.L..same_year:SV
## 1072 0.000000e+00          W.L..same_year:IP
## 1073 0.000000e+00     W.L..same_year:H.pitch
## 1074 0.000000e+00    W.L..same_year:HR.pitch
## 1075 0.000000e+00    W.L..same_year:BB.pitch
## 1076 0.000000e+00   W.L..same_year:IBB.pitch
## 1077 0.000000e+00    W.L..same_year:SO.pitch
## 1078 0.000000e+00   W.L..same_year:HBP.pitch
## 1079 0.000000e+00          W.L..same_year:BK
## 1080 0.000000e+00          W.L..same_year:WP
## 1081 0.000000e+00          W.L..same_year:BF
## 1082 0.000000e+00         W.L..same_year:FIP
## 1083 0.000000e+00        W.L..same_year:WHIP
## 1084 0.000000e+00          W.L..same_year:H9
## 1085 0.000000e+00         W.L..same_year:HR9
## 1086 0.000000e+00         W.L..same_year:BB9
## 1087 0.000000e+00         W.L..same_year:SO9
## 1088 0.000000e+00        W.L..same_year:SO.W
## 1089 0.000000e+00           W.L..same_year:G
## 1090 0.000000e+00         W.L..same_year:Inn
## 1091 0.000000e+00          W.L..same_year:Ch
## 1092 0.000000e+00          W.L..same_year:PO
## 1093 0.000000e+00           W.L..same_year:A
## 1094 0.000000e+00           W.L..same_year:E
## 1095 0.000000e+00          W.L..same_year:DP
## 1096 0.000000e+00        W.L..same_year:Fld.
## 1097 0.000000e+00        W.L..same_year:RF.9
## 1098 0.000000e+00        W.L..same_year:RF.G
## 1099 0.000000e+00 W.L..same_year:tot_fa_war3
```

```
## 1100 0.000000e+00     W.L..same_year:num_fas
## 1101 0.000000e+00                    GF:SHO
## 1102 0.000000e+00                     GF:SV
## 1103 0.000000e+00                     GF:IP
## 1104 0.000000e+00                  GF:H.pitch
## 1105 0.000000e+00                 GF:HR.pitch
## 1106 0.000000e+00                 GF:BB.pitch
## 1107 0.000000e+00                GF:IBB.pitch
## 1108 0.000000e+00                 GF:SO.pitch
## 1109 0.000000e+00                GF:HBP.pitch
## 1110 0.000000e+00                       GF:BK
## 1111 0.000000e+00                       GF:WP
## 1112 0.000000e+00                       GF:BF
## 1113 0.000000e+00                      GF:FIP
## 1114 0.000000e+00                     GF:WHIP
## 1115 0.000000e+00                       GF:H9
## 1116 0.000000e+00                      GF:HR9
## 1117 0.000000e+00                      GF:BB9
## 1118 0.000000e+00                      GF:SO9
## 1119 0.000000e+00                     GF:SO.W
## 1120 0.000000e+00                        GF:G
## 1121 0.000000e+00                      GF:Inn
## 1122 0.000000e+00                       GF:Ch
## 1123 0.000000e+00                       GF:PO
## 1124 0.000000e+00                        GF:A
## 1125 0.000000e+00                        GF:E
## 1126 0.000000e+00                       GF:DP
## 1127 0.000000e+00                     GF:Fld.
## 1128 0.000000e+00                     GF:RF.9
## 1129 0.000000e+00                     GF:RF.G
## 1130 0.000000e+00            GF:tot_fa_war3
## 1131 0.000000e+00                GF:num_fas
## 1132 0.000000e+00                    SHO:SV
## 1134 0.000000e+00                 SHO:H.pitch
## 1135 0.000000e+00                SHO:HR.pitch
## 1136 0.000000e+00                SHO:BB.pitch
## 1137 0.000000e+00               SHO:IBB.pitch
## 1138 0.000000e+00                SHO:SO.pitch
## 1139 0.000000e+00               SHO:HBP.pitch
## 1140 0.000000e+00                      SHO:BK
## 1141 0.000000e+00                      SHO:WP
## 1142 0.000000e+00                      SHO:BF
## 1143 0.000000e+00                     SHO:FIP
## 1144 0.000000e+00                    SHO:WHIP
## 1145 0.000000e+00                      SHO:H9
## 1146 0.000000e+00                     SHO:HR9
## 1147 0.000000e+00                     SHO:BB9
## 1148 0.000000e+00                     SHO:SO9
## 1149 0.000000e+00                    SHO:SO.W
## 1150 0.000000e+00                       SHO:G
## 1151 0.000000e+00                     SHO:Inn
## 1152 0.000000e+00                      SHO:Ch
## 1153 0.000000e+00                      SHO:PO
## 1154 0.000000e+00                       SHO:A
```

```
## 1156 0.000000e+00                  SHO:DP
## 1157 0.000000e+00                 SHO:Fld.
## 1158 0.000000e+00                 SHO:RF.9
## 1159 0.000000e+00                 SHO:RF.G
## 1160 0.000000e+00           SHO:tot_fa_war3
## 1161 0.000000e+00               SHO:num_fas
## 1162 0.000000e+00                     SV:IP
## 1163 0.000000e+00                SV:H.pitch
## 1164 0.000000e+00               SV:HR.pitch
## 1165 0.000000e+00               SV:BB.pitch
## 1166 0.000000e+00              SV:IBB.pitch
## 1167 0.000000e+00               SV:SO.pitch
## 1168 0.000000e+00              SV:HBP.pitch
## 1169 0.000000e+00                     SV:BK
## 1170 0.000000e+00                     SV:WP
## 1171 0.000000e+00                     SV:BF
## 1172 0.000000e+00                    SV:FIP
## 1173 0.000000e+00                   SV:WHIP
## 1174 0.000000e+00                     SV:H9
## 1175 0.000000e+00                    SV:HR9
## 1176 0.000000e+00                    SV:BB9
## 1177 0.000000e+00                    SV:SO9
## 1178 0.000000e+00                   SV:SO.W
## 1179 0.000000e+00                      SV:G
## 1180 0.000000e+00                    SV:Inn
## 1181 0.000000e+00                     SV:Ch
## 1182 0.000000e+00                     SV:PO
## 1183 0.000000e+00                      SV:A
## 1184 0.000000e+00                      SV:E
## 1185 0.000000e+00                     SV:DP
## 1186 0.000000e+00                    SV:Fld.
## 1187 0.000000e+00                    SV:RF.9
## 1188 0.000000e+00                    SV:RF.G
## 1189 0.000000e+00             SV:tot_fa_war3
## 1190 0.000000e+00                 SV:num_fas
## 1191 0.000000e+00                  IP:H.pitch
## 1192 0.000000e+00                 IP:HR.pitch
## 1193 0.000000e+00                 IP:BB.pitch
## 1194 0.000000e+00                IP:IBB.pitch
## 1195 0.000000e+00                 IP:SO.pitch
## 1196 0.000000e+00                IP:HBP.pitch
## 1197 0.000000e+00                       IP:BK
## 1198 0.000000e+00                       IP:WP
## 1199 0.000000e+00                       IP:BF
## 1200 0.000000e+00                      IP:FIP
## 1201 0.000000e+00                     IP:WHIP
## 1202 0.000000e+00                       IP:H9
## 1203 0.000000e+00                      IP:HR9
## 1204 0.000000e+00                      IP:BB9
## 1205 0.000000e+00                      IP:SO9
## 1206 0.000000e+00                     IP:SO.W
## 1207 0.000000e+00                        IP:G
## 1208 0.000000e+00                      IP:Inn
## 1209 0.000000e+00                       IP:Ch
```

```
## 1210 0.000000e+00                   IP:PO
## 1211 0.000000e+00                    IP:A
## 1212 0.000000e+00                    IP:E
## 1213 0.000000e+00                   IP:DP
## 1214 0.000000e+00                  IP:Fld.
## 1215 0.000000e+00                  IP:RF.9
## 1216 0.000000e+00                  IP:RF.G
## 1217 0.000000e+00            IP:tot_fa_war3
## 1218 0.000000e+00                IP:num_fas
## 1219 0.000000e+00          H.pitch:HR.pitch
## 1220 0.000000e+00          H.pitch:BB.pitch
## 1221 0.000000e+00         H.pitch:IBB.pitch
## 1222 0.000000e+00          H.pitch:SO.pitch
## 1223 0.000000e+00         H.pitch:HBP.pitch
## 1224 0.000000e+00                H.pitch:BK
## 1225 0.000000e+00                H.pitch:WP
## 1226 0.000000e+00                H.pitch:BF
## 1227 0.000000e+00               H.pitch:FIP
## 1228 0.000000e+00              H.pitch:WHIP
## 1229 0.000000e+00                H.pitch:H9
## 1230 0.000000e+00               H.pitch:HR9
## 1231 0.000000e+00               H.pitch:BB9
## 1232 0.000000e+00               H.pitch:SO9
## 1233 0.000000e+00              H.pitch:SO.W
## 1234 0.000000e+00                 H.pitch:G
## 1235 0.000000e+00               H.pitch:Inn
## 1236 0.000000e+00                H.pitch:Ch
## 1237 0.000000e+00                H.pitch:PO
## 1238 0.000000e+00                 H.pitch:A
## 1239 0.000000e+00                 H.pitch:E
## 1240 0.000000e+00                H.pitch:DP
## 1241 0.000000e+00               H.pitch:Fld.
## 1242 0.000000e+00               H.pitch:RF.9
## 1243 0.000000e+00               H.pitch:RF.G
## 1244 0.000000e+00        H.pitch:tot_fa_war3
## 1245 0.000000e+00            H.pitch:num_fas
## 1246 0.000000e+00          HR.pitch:BB.pitch
## 1247 0.000000e+00         HR.pitch:IBB.pitch
## 1248 0.000000e+00          HR.pitch:SO.pitch
## 1249 0.000000e+00         HR.pitch:HBP.pitch
## 1250 0.000000e+00                HR.pitch:BK
## 1251 0.000000e+00                HR.pitch:WP
## 1252 0.000000e+00                HR.pitch:BF
## 1253 0.000000e+00               HR.pitch:FIP
## 1254 0.000000e+00              HR.pitch:WHIP
## 1255 0.000000e+00                HR.pitch:H9
## 1256 0.000000e+00               HR.pitch:HR9
## 1257 0.000000e+00               HR.pitch:BB9
## 1258 0.000000e+00               HR.pitch:SO9
## 1259 0.000000e+00              HR.pitch:SO.W
## 1260 0.000000e+00                 HR.pitch:G
## 1261 0.000000e+00               HR.pitch:Inn
## 1262 0.000000e+00                HR.pitch:Ch
## 1263 0.000000e+00                HR.pitch:PO
```

```
## 1264 0.000000e+00                HR.pitch:A
## 1265 0.000000e+00                HR.pitch:E
## 1266 0.000000e+00               HR.pitch:DP
## 1267 0.000000e+00              HR.pitch:Fld.
## 1268 0.000000e+00              HR.pitch:RF.9
## 1269 0.000000e+00              HR.pitch:RF.G
## 1270 0.000000e+00       HR.pitch:tot_fa_war3
## 1271 0.000000e+00           HR.pitch:num_fas
## 1272 0.000000e+00         BB.pitch:IBB.pitch
## 1273 0.000000e+00         BB.pitch:SO.pitch
## 1274 0.000000e+00        BB.pitch:HBP.pitch
## 1275 0.000000e+00                BB.pitch:BK
## 1276 0.000000e+00                BB.pitch:WP
## 1277 0.000000e+00                BB.pitch:BF
## 1278 0.000000e+00               BB.pitch:FIP
## 1279 0.000000e+00              BB.pitch:WHIP
## 1280 0.000000e+00                BB.pitch:H9
## 1281 0.000000e+00               BB.pitch:HR9
## 1282 0.000000e+00               BB.pitch:BB9
## 1283 0.000000e+00               BB.pitch:SO9
## 1284 0.000000e+00              BB.pitch:SO.W
## 1285 0.000000e+00                 BB.pitch:G
## 1286 0.000000e+00               BB.pitch:Inn
## 1287 0.000000e+00                BB.pitch:Ch
## 1288 0.000000e+00                BB.pitch:PO
## 1289 0.000000e+00                 BB.pitch:A
## 1290 0.000000e+00                 BB.pitch:E
## 1291 0.000000e+00                BB.pitch:DP
## 1292 0.000000e+00              BB.pitch:Fld.
## 1293 0.000000e+00              BB.pitch:RF.9
## 1294 0.000000e+00              BB.pitch:RF.G
## 1295 0.000000e+00       BB.pitch:tot_fa_war3
## 1296 0.000000e+00           BB.pitch:num_fas
## 1297 0.000000e+00         IBB.pitch:SO.pitch
## 1298 0.000000e+00        IBB.pitch:HBP.pitch
## 1299 0.000000e+00                IBB.pitch:BK
## 1300 0.000000e+00                IBB.pitch:WP
## 1301 0.000000e+00                IBB.pitch:BF
## 1302 0.000000e+00               IBB.pitch:FIP
## 1303 0.000000e+00              IBB.pitch:WHIP
## 1304 0.000000e+00                IBB.pitch:H9
## 1305 0.000000e+00               IBB.pitch:HR9
## 1306 0.000000e+00               IBB.pitch:BB9
## 1307 0.000000e+00               IBB.pitch:SO9
## 1308 0.000000e+00              IBB.pitch:SO.W
## 1309 0.000000e+00                 IBB.pitch:G
## 1310 0.000000e+00               IBB.pitch:Inn
## 1311 0.000000e+00                IBB.pitch:Ch
## 1312 0.000000e+00                IBB.pitch:PO
## 1313 0.000000e+00                 IBB.pitch:A
## 1314 0.000000e+00                 IBB.pitch:E
## 1315 0.000000e+00                IBB.pitch:DP
## 1316 0.000000e+00              IBB.pitch:Fld.
## 1317 0.000000e+00              IBB.pitch:RF.9
```

```
## 1318 0.000000e+00            IBB.pitch:RF.G
## 1319 0.000000e+00     IBB.pitch:tot_fa_war3
## 1320 0.000000e+00         IBB.pitch:num_fas
## 1321 0.000000e+00        SO.pitch:HBP.pitch
## 1322 0.000000e+00               SO.pitch:BK
## 1323 0.000000e+00               SO.pitch:WP
## 1324 0.000000e+00               SO.pitch:BF
## 1325 0.000000e+00             SO.pitch:FIP
## 1326 0.000000e+00            SO.pitch:WHIP
## 1327 0.000000e+00              SO.pitch:H9
## 1328 0.000000e+00             SO.pitch:HR9
## 1329 0.000000e+00             SO.pitch:BB9
## 1330 0.000000e+00             SO.pitch:SO9
## 1331 0.000000e+00            SO.pitch:SO.W
## 1332 0.000000e+00               SO.pitch:G
## 1333 0.000000e+00             SO.pitch:Inn
## 1334 0.000000e+00              SO.pitch:Ch
## 1335 0.000000e+00              SO.pitch:PO
## 1336 0.000000e+00               SO.pitch:A
## 1337 0.000000e+00               SO.pitch:E
## 1338 0.000000e+00              SO.pitch:DP
## 1339 0.000000e+00            SO.pitch:Fld.
## 1340 0.000000e+00            SO.pitch:RF.9
## 1341 0.000000e+00            SO.pitch:RF.G
## 1342 0.000000e+00     SO.pitch:tot_fa_war3
## 1343 0.000000e+00         SO.pitch:num_fas
## 1344 0.000000e+00             HBP.pitch:BK
## 1345 0.000000e+00             HBP.pitch:WP
## 1346 0.000000e+00             HBP.pitch:BF
## 1347 0.000000e+00           HBP.pitch:FIP
## 1348 0.000000e+00          HBP.pitch:WHIP
## 1349 0.000000e+00            HBP.pitch:H9
## 1350 0.000000e+00           HBP.pitch:HR9
## 1351 0.000000e+00           HBP.pitch:BB9
## 1352 0.000000e+00           HBP.pitch:SO9
## 1353 0.000000e+00          HBP.pitch:SO.W
## 1354 0.000000e+00             HBP.pitch:G
## 1355 0.000000e+00           HBP.pitch:Inn
## 1356 0.000000e+00            HBP.pitch:Ch
## 1357 0.000000e+00            HBP.pitch:PO
## 1358 0.000000e+00             HBP.pitch:A
## 1359 0.000000e+00             HBP.pitch:E
## 1360 0.000000e+00            HBP.pitch:DP
## 1361 0.000000e+00          HBP.pitch:Fld.
## 1362 0.000000e+00          HBP.pitch:RF.9
## 1363 0.000000e+00          HBP.pitch:RF.G
## 1365 0.000000e+00       HBP.pitch:num_fas
## 1366 0.000000e+00                 BK:WP
## 1367 0.000000e+00                 BK:BF
## 1368 0.000000e+00               BK:FIP
## 1369 0.000000e+00              BK:WHIP
## 1370 0.000000e+00                BK:H9
## 1372 0.000000e+00               BK:BB9
## 1373 0.000000e+00               BK:SO9
```

```
## 1374 0.000000e+00                  BK:SO.W
## 1375 0.000000e+00                     BK:G
## 1376 0.000000e+00                   BK:Inn
## 1377 0.000000e+00                    BK:Ch
## 1378 0.000000e+00                    BK:PO
## 1379 0.000000e+00                     BK:A
## 1380 0.000000e+00                     BK:E
## 1381 0.000000e+00                    BK:DP
## 1382 0.000000e+00                  BK:Fld.
## 1383 0.000000e+00                  BK:RF.9
## 1384 0.000000e+00                  BK:RF.G
## 1385 0.000000e+00            BK:tot_fa_war3
## 1386 0.000000e+00                BK:num_fas
## 1387 0.000000e+00                     WP:BF
## 1388 0.000000e+00                    WP:FIP
## 1389 0.000000e+00                   WP:WHIP
## 1390 0.000000e+00                     WP:H9
## 1391 0.000000e+00                    WP:HR9
## 1392 0.000000e+00                    WP:BB9
## 1393 0.000000e+00                    WP:SO9
## 1394 0.000000e+00                   WP:SO.W
## 1395 0.000000e+00                      WP:G
## 1396 0.000000e+00                    WP:Inn
## 1397 0.000000e+00                     WP:Ch
## 1398 0.000000e+00                     WP:PO
## 1399 0.000000e+00                      WP:A
## 1400 0.000000e+00                      WP:E
## 1401 0.000000e+00                     WP:DP
## 1402 0.000000e+00                   WP:Fld.
## 1403 0.000000e+00                   WP:RF.9
## 1404 0.000000e+00                   WP:RF.G
## 1405 0.000000e+00            WP:tot_fa_war3
## 1406 0.000000e+00                WP:num_fas
## 1407 0.000000e+00                     BF:FIP
## 1408 0.000000e+00                    BF:WHIP
## 1409 0.000000e+00                      BF:H9
## 1410 0.000000e+00                     BF:HR9
## 1411 0.000000e+00                     BF:BB9
## 1412 0.000000e+00                     BF:SO9
## 1413 0.000000e+00                    BF:SO.W
## 1414 0.000000e+00                       BF:G
## 1415 0.000000e+00                     BF:Inn
## 1416 0.000000e+00                      BF:Ch
## 1417 0.000000e+00                      BF:PO
## 1418 0.000000e+00                       BF:A
## 1419 0.000000e+00                       BF:E
## 1420 0.000000e+00                      BF:DP
## 1421 0.000000e+00                    BF:Fld.
## 1422 0.000000e+00                    BF:RF.9
## 1423 0.000000e+00                    BF:RF.G
## 1424 0.000000e+00            BF:tot_fa_war3
## 1425 0.000000e+00                BF:num_fas
## 1426 0.000000e+00                  FIP:WHIP
## 1427 0.000000e+00                    FIP:H9
```

```
## 1428 0.000000e+00                  FIP:HR9
## 1429 0.000000e+00                  FIP:BB9
## 1430 0.000000e+00                  FIP:SO9
## 1431 0.000000e+00                 FIP:SO.W
## 1432 0.000000e+00                    FIP:G
## 1433 0.000000e+00                  FIP:Inn
## 1434 0.000000e+00                   FIP:Ch
## 1435 0.000000e+00                   FIP:PO
## 1436 0.000000e+00                    FIP:A
## 1437 0.000000e+00                    FIP:E
## 1438 0.000000e+00                   FIP:DP
## 1439 0.000000e+00                 FIP:Fld.
## 1440 0.000000e+00                 FIP:RF.9
## 1441 0.000000e+00                 FIP:RF.G
## 1442 0.000000e+00           FIP:tot_fa_war3
## 1443 0.000000e+00               FIP:num_fas
## 1444 0.000000e+00                   WHIP:H9
## 1445 0.000000e+00                  WHIP:HR9
## 1446 0.000000e+00                  WHIP:BB9
## 1447 0.000000e+00                  WHIP:SO9
## 1448 0.000000e+00                 WHIP:SO.W
## 1449 0.000000e+00                    WHIP:G
## 1450 0.000000e+00                  WHIP:Inn
## 1451 0.000000e+00                   WHIP:Ch
## 1452 0.000000e+00                   WHIP:PO
## 1453 0.000000e+00                    WHIP:A
## 1454 0.000000e+00                    WHIP:E
## 1455 0.000000e+00                   WHIP:DP
## 1456 0.000000e+00                 WHIP:Fld.
## 1457 0.000000e+00                 WHIP:RF.9
## 1458 0.000000e+00                 WHIP:RF.G
## 1459 0.000000e+00          WHIP:tot_fa_war3
## 1460 0.000000e+00              WHIP:num_fas
## 1461 0.000000e+00                    H9:HR9
## 1462 0.000000e+00                    H9:BB9
## 1463 0.000000e+00                    H9:SO9
## 1464 0.000000e+00                   H9:SO.W
## 1465 0.000000e+00                      H9:G
## 1466 0.000000e+00                    H9:Inn
## 1467 0.000000e+00                     H9:Ch
## 1468 0.000000e+00                     H9:PO
## 1469 0.000000e+00                      H9:A
## 1470 0.000000e+00                      H9:E
## 1471 0.000000e+00                     H9:DP
## 1472 0.000000e+00                   H9:Fld.
## 1473 0.000000e+00                   H9:RF.9
## 1474 0.000000e+00                   H9:RF.G
## 1475 0.000000e+00            H9:tot_fa_war3
## 1476 0.000000e+00                H9:num_fas
## 1477 0.000000e+00                   HR9:BB9
## 1478 0.000000e+00                   HR9:SO9
## 1479 0.000000e+00                  HR9:SO.W
## 1480 0.000000e+00                     HR9:G
## 1481 0.000000e+00                   HR9:Inn
```

```
## 1482 0.000000e+00                  HR9:Ch
## 1483 0.000000e+00                  HR9:PO
## 1484 0.000000e+00                   HR9:A
## 1485 0.000000e+00                   HR9:E
## 1486 0.000000e+00                  HR9:DP
## 1487 0.000000e+00                 HR9:Fld.
## 1488 0.000000e+00                 HR9:RF.9
## 1489 0.000000e+00                 HR9:RF.G
## 1490 0.000000e+00           HR9:tot_fa_war3
## 1491 0.000000e+00               HR9:num_fas
## 1492 0.000000e+00                  BB9:SO9
## 1493 0.000000e+00                 BB9:SO.W
## 1494 0.000000e+00                    BB9:G
## 1495 0.000000e+00                  BB9:Inn
## 1496 0.000000e+00                   BB9:Ch
## 1497 0.000000e+00                   BB9:PO
## 1498 0.000000e+00                    BB9:A
## 1499 0.000000e+00                    BB9:E
## 1500 0.000000e+00                   BB9:DP
## 1501 0.000000e+00                  BB9:Fld.
## 1502 0.000000e+00                  BB9:RF.9
## 1503 0.000000e+00                  BB9:RF.G
## 1504 0.000000e+00           BB9:tot_fa_war3
## 1505 0.000000e+00               BB9:num_fas
## 1506 0.000000e+00                 SO9:SO.W
## 1507 0.000000e+00                    SO9:G
## 1508 0.000000e+00                  SO9:Inn
## 1509 0.000000e+00                   SO9:Ch
## 1510 0.000000e+00                   SO9:PO
## 1511 0.000000e+00                    SO9:A
## 1512 0.000000e+00                    SO9:E
## 1513 0.000000e+00                   SO9:DP
## 1514 0.000000e+00                  SO9:Fld.
## 1515 0.000000e+00                  SO9:RF.9
## 1516 0.000000e+00                  SO9:RF.G
## 1517 0.000000e+00           SO9:tot_fa_war3
## 1518 0.000000e+00               SO9:num_fas
## 1519 0.000000e+00                  SO.W:G
## 1520 0.000000e+00                SO.W:Inn
## 1521 0.000000e+00                 SO.W:Ch
## 1522 0.000000e+00                 SO.W:PO
## 1523 0.000000e+00                  SO.W:A
## 1525 0.000000e+00                 SO.W:DP
## 1526 0.000000e+00               SO.W:Fld.
## 1527 0.000000e+00               SO.W:RF.9
## 1528 0.000000e+00               SO.W:RF.G
## 1530 0.000000e+00           SO.W:num_fas
## 1531 0.000000e+00                  G:Inn
## 1532 0.000000e+00                   G:Ch
## 1533 0.000000e+00                   G:PO
## 1534 0.000000e+00                    G:A
## 1535 0.000000e+00                    G:E
## 1536 0.000000e+00                   G:DP
## 1537 0.000000e+00                  G:Fld.
```

```
## 1538 0.000000e+00                 G:RF.9
## 1539 0.000000e+00                 G:RF.G
## 1540 0.000000e+00           G:tot_fa_war3
## 1541 0.000000e+00               G:num_fas
## 1542 0.000000e+00                 Inn:Ch
## 1543 0.000000e+00                 Inn:PO
## 1544 0.000000e+00                  Inn:A
## 1545 0.000000e+00                  Inn:E
## 1546 0.000000e+00                 Inn:DP
## 1547 0.000000e+00               Inn:Fld.
## 1548 0.000000e+00                 Inn:RF.9
## 1549 0.000000e+00                 Inn:RF.G
## 1550 0.000000e+00           Inn:tot_fa_war3
## 1551 0.000000e+00               Inn:num_fas
## 1552 0.000000e+00                   Ch:PO
## 1553 0.000000e+00                    Ch:A
## 1554 0.000000e+00                    Ch:E
## 1555 0.000000e+00                   Ch:DP
## 1556 0.000000e+00                 Ch:Fld.
## 1557 0.000000e+00                 Ch:RF.9
## 1558 0.000000e+00                 Ch:RF.G
## 1559 0.000000e+00           Ch:tot_fa_war3
## 1560 0.000000e+00               Ch:num_fas
## 1561 0.000000e+00                    PO:A
## 1562 0.000000e+00                    PO:E
## 1563 0.000000e+00                   PO:DP
## 1564 0.000000e+00                 PO:Fld.
## 1565 0.000000e+00                 PO:RF.9
## 1566 0.000000e+00                 PO:RF.G
## 1567 0.000000e+00           PO:tot_fa_war3
## 1568 0.000000e+00               PO:num_fas
## 1569 0.000000e+00                    A:E
## 1570 0.000000e+00                   A:DP
## 1571 0.000000e+00                 A:Fld.
## 1572 0.000000e+00                 A:RF.9
## 1573 0.000000e+00                 A:RF.G
## 1574 0.000000e+00           A:tot_fa_war3
## 1575 0.000000e+00               A:num_fas
## 1576 0.000000e+00                   E:DP
## 1577 0.000000e+00                 E:Fld.
## 1578 0.000000e+00                 E:RF.9
## 1579 0.000000e+00                 E:RF.G
## 1580 0.000000e+00           E:tot_fa_war3
## 1581 0.000000e+00               E:num_fas
## 1582 0.000000e+00                 DP:Fld.
## 1583 0.000000e+00                 DP:RF.9
## 1584 0.000000e+00                 DP:RF.G
## 1585 0.000000e+00           DP:tot_fa_war3
## 1586 0.000000e+00               DP:num_fas
## 1587 0.000000e+00                Fld.:RF.9
## 1588 0.000000e+00                Fld.:RF.G
## 1589 0.000000e+00          Fld.:tot_fa_war3
## 1590 0.000000e+00              Fld.:num_fas
## 1591 0.000000e+00                RF.9:RF.G
```

```
## 1592 0.000000e+00           RF.9:tot_fa_war3
## 1593 0.000000e+00               RF.9:num_fas
## 1594 0.000000e+00           RF.G:tot_fa_war3
## 1595 0.000000e+00               RF.G:num_fas
## 1596 0.000000e+00        tot_fa_war3:num_fas
```

```
yhats.fullinteraction.train = predict(lassos.fullinteraction, X.fullinteraction)
lassosfullinteraction.trainRMSE = RMSE(train.df$W.L..next_year, yhats.fullinteraction.train) # train RM
lassosfullinteraction.trainR2 = R2(train.df$W.L..next_year, yhats.fullinteraction.train) # train R2

yhats.fullinteraction.test = predict(lassos.fullinteraction, X.fullinteraction.test)
#plot(RMSE.lassos.fullinteraction.test~log(lassos.fullinteraction$lambda, 10), type='l')
lassosfullinteraction.testRMSE = RMSE(test.df$W.L..next_year, yhats.fullinteraction.test) # train RMSE
lassosfullinteraction.testR2 = R2(test.df$W.L..next_year, yhats.fullinteraction.test) # train R2
```

```
# Stepwise
lm.step = step(lm.full, scope=c(lower=formula(W.L..next_year~1),
                                upper=lm.fullinteraction), trace=0, direction="both")
formula(lm.step)
```

```
## W.L..next_year ~ Age.bat + PA + AB + H.bat + X3B + BA + OBP +
##     OPS + OPSplus + Age.pitch + SHO + SV + BK + H9 + HR9 + SO.W +
##     Inn + PO + tot_fa_war3 + num_fas
```

```
imp <- as.data.frame(varImp(lm.step))
imp <- data.frame(overall = imp$Overall,
           names = rownames(imp))
imp[order(imp$overall,decreasing = T),]
```

```
##     overall       names
## 19 4.271679 tot_fa_war3
## 1  4.088264     Age.bat
## 15 3.787488         HR9
## 4  3.608642       H.bat
## 14 3.550756          H9
## 5  3.527383         X3B
## 3  3.480727          AB
## 8  3.431419         OPS
## 20 3.077205     num_fas
## 16 3.013236        SO.W
## 10 2.944068   Age.pitch
## 11 2.872957         SHO
## 18 2.789851          PO
## 6  2.779308          BA
## 2  2.328917          PA
## 17 2.216834         Inn
## 13 2.145402          BK
## 9  1.933956     OPSplus
## 12 1.585605          SV
## 7  1.447517         OBP
```

```
lmstep.trainRMSE = RMSE(train.df$W.L..next_year, predict(lm.step, newdata=train.df))
lmstep.testRMSE = RMSE(test.df$W.L..next_year, predict(lm.step, newdata=test.df))
lmstep.trainR2 = R2(train.df$W.L..next_year, predict(lm.step, newdata=train.df))
lmstep.testR2 = R2(test.df$W.L..next_year, predict(lm.step, newdata=test.df))
```

```
# model comparison
RMSE.df = data.frame(trainRMSE = c(baseline.trainRMSE,
                                   lmfull.trainRMSE,
                                   lmfullinteraction.trainRMSE,
                                   ridgesfull.trainRMSE,
                                   ridgesfullinteraction.trainRMSE,
                                   lassosfull.trainRMSE,
                                   lassosfullinteraction.trainRMSE,
                                   lmstep.trainRMSE),
                     testRMSE = c(baseline.testRMSE,
                                   lmfull.testRMSE,
                                   lmfullinteraction.testRMSE,
                                   ridgesfull.testRMSE,
                                   ridgesfullinteraction.testRMSE,
                                   lassosfull.testRMSE,
                                   lassosfullinteraction.testRMSE,
                                   lmstep.testRMSE),
                     trainR2 = c(baseline.trainR2,
                                   lmfull.trainR2,
                                   lmfullinteraction.trainR2,
                                   ridgesfull.trainR2,
                                   ridgesfullinteraction.trainR2,
                                   lassosfull.trainR2,
                                   lassosfullinteraction.trainR2,
                                   lmstep.trainR2),
                     testR2 = c(baseline.testR2,
                                   lmfull.testR2,
                                   lmfullinteraction.testR2,
                                   ridgesfull.testR2,
                                   ridgesfullinteraction.testR2,
                                   lassosfull.testR2,
                                   lassosfullinteraction.testR2,
                                   lmstep.testR2))
rownames(RMSE.df) <- c("baseline", "full", "full interaction",
                       "ridge full", "ridge full interaction",
                       "lasso full", "lasso full interaction",
                       "step")
RMSE.df
```

```
##                           trainRMSE    testRMSE   trainR2        testR2
## baseline                6.313658e+00    6.881806 0.2761220  2.758521e-01
## full                    5.584315e+00    7.371851 0.4337046  1.690488e-01
## full interaction        2.287387e-07 5581.291147 1.0000000 -4.763113e+05
## ridge full              5.717836e+00    6.998695 0.4063006  2.510436e-01
## ridge full interaction  5.588766e+00    7.145447 0.4328014  2.193053e-01
## lasso full              5.802932e+00    6.936734 0.3884976  2.642462e-01
## lasso full interaction  5.767367e+00    7.021256 0.3959702  2.462071e-01
## step                    5.681231e+00    7.284439 0.4138778  1.886379e-01
```

Decision Tree/Random Forest

```
set.seed(139)
library(rpart)

RMSE = function(y,yhat){
  return(sqrt(mean((y-yhat)^2)))
}

test.df = subset(test.df, test.df$Tm != 'CLE')
tree1 = rpart(formula(lm.full),data=train.df, control = list(minsplit=1,cp=0,maxdepth=20))
yhat.tree1.train = predict(tree1)
yhat.tree1.test = predict(tree1, newdata = test.df)
RMSE.tree1.train = RMSE(train.df$W.L..next_year,yhat.tree1.train)
RMSE.tree1.test = RMSE(test.df$W.L..next_year,yhat.tree1.test)
data.frame(train=RMSE.tree1.train,test=RMSE.tree1.test)
```

```
##      train     test
## 1 3.857545 8.719118
```

```
best.cp = tree1$cptable[,"CP"][which.min(tree1$cptable[,"xerror"])]
tree2 = prune(tree1,best.cp)
yhat.tree2.train = predict(tree2)
yhat.tree2.test = predict(tree2,newdata=test.df)
RMSE.tree2.train = RMSE(train.df$W.L..next_year,yhat.tree2.train)
RMSE.tree2.test = RMSE(test.df$W.L..next_year,yhat.tree2.test)
data.frame(train=RMSE.tree2.train,test=RMSE.tree2.test)
```

```
##      train     test
## 1 6.103694 8.010153
```

```
tree3 = rpart(W.L..next_year~W.L..same_year + Age.pitch + WHIP,
              data=train.df, control = list(minsplit=1, cp=0, maxdepth=20))
yhat.tree3.train = predict(tree3)
yhat.tree3.test = predict(tree3, newdata = test.df)
RMSE.tree3.train = RMSE(train.df$W.L..next_year,yhat.tree3.train)
RMSE.tree3.test = RMSE(test.df$W.L..next_year,yhat.tree3.test)
data.frame(train=RMSE.tree3.train,test=RMSE.tree3.test)
```

```
##     train     test
## 1 5.19188 8.384536
```

```
best.cp = tree3$cptable[,"CP"][which.min(tree3$cptable[,"xerror"])]
tree4 = prune(tree3,best.cp)
yhat.tree4.train = predict(tree4)
yhat.tree4.test = predict(tree4,newdata=test.df)
RMSE.tree4.train = RMSE(train.df$W.L..next_year,yhat.tree4.train)
RMSE.tree4.test = RMSE(test.df$W.L..next_year,yhat.tree4.test)
data.frame(train=RMSE.tree4.train,test=RMSE.tree4.test)
```

```
##      train     test
## 1 6.529905 7.587558
```

```
library(randomForest)
```

```
## Warning: package 'randomForest' was built under R version 4.2.2
```

```
## randomForest 4.7-1.1
```

```
## Type rfNews() to see new features/changes/bug fixes.
```

```
##
## Attaching package: 'randomForest'
```

```
## The following object is masked from 'package:ggplot2':
##
##     margin
```

```
## The following object is masked from 'package:dplyr':
##
##     combine
```

```
set.seed(139)
maxnodes = c(100,200,500)
ntree= 200
rmses.bag = rep(NA,length(maxnodes))
bestRMSE = sd(train.df$W.L..next_year)

for(i in 1:length(maxnodes)){
  bagtemp = randomForest(formula(lm.full),data=train.df,
                         mtry=56, maxnodes=maxnodes[i], ntree=ntree)
  rmses.bag[i]=RMSE(train.df$W.L..next_year, bagtemp$predicted)
  if(rmses.bag[i]<bestRMSE){
    best_maxnodes = maxnodes[i]
    bestRMSE=rmses.bag[i]
    bag=bagtemp
  }
}
data.frame(maxnodes=maxnodes, RMSE=rmses.bag)
```

```
##   maxnodes     RMSE
## 1      100 6.446066
## 2      200 6.386760
## 3      500 6.400181
```

```
yhat.bag.train = predict(bag)
yhat.bag.test = predict(bag, newdata = test.df)
RMSE.bag.train = RMSE(train.df$W.L..next_year,yhat.bag.train)
RMSE.bag.test = RMSE(test.df$W.L..next_year,yhat.bag.test)
data.frame(train=RMSE.bag.train,test=RMSE.bag.test)
```

```
##     train     test
## 1 6.38676 7.146759
```

```
library(randomForest)
library(varImp)
```

```
## Warning: package 'varImp' was built under R version 4.2.2
```

```
## Loading required package: measures
```

```
## Warning: package 'measures' was built under R version 4.2.2
```

```
##
## Attaching package: 'measures'
```

```
## The following object is masked _by_ '.GlobalEnv':
##
##     RMSE
```

```
## The following objects are masked from 'package:caret':
##
##     MAE, RMSE
```

```
## Loading required package: party
```

```
## Warning: package 'party' was built under R version 4.2.2
```

```
## Loading required package: grid
```

```
## Loading required package: mvtnorm
```

```
## Loading required package: modeltools
```

```
## Loading required package: stats4
```

```
## Loading required package: strucchange
```

```
## Warning: package 'strucchange' was built under R version 4.2.2
```

```
## Loading required package: zoo
```

```
## Warning: package 'zoo' was built under R version 4.2.2
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
## Loading required package: sandwich
```

```
## Warning: package 'sandwich' was built under R version 4.2.2
```

```
##
## Attaching package: 'varImp'
```

```
## The following object is masked from 'package:caret':
##
##     varImp
```

```
set.seed(139)
maxnodes = c(100,200,500)
mtry = c(15, 25, 35, 45, 55)
ntree=200
pars = expand.grid(maxnodes=maxnodes,mtry=mtry)
RMSEs = rep(NA,nrow(pars))
bestRMSE = sd(train.df$W.L..next_year)

for(i in 1:nrow(pars)){
  rftemp = randomForest(formula(lm.full),data=train.df,
                        mtry=pars$mtry[i], maxnodes=pars$maxnodes[i], ntree=ntree)
  RMSEs[i]=RMSE(train.df$W.L..next_year, rftemp$predicted)
  if(RMSEs[i]<bestRMSE){
    best_maxnodes = maxnodes[i]
    bestRMSE=RMSEs[i]
    rf1=rftemp
  }
}
data.frame(maxnodes=pars$maxnodes,mtry=pars$mtry,RMSE=RMSEs)
```

```
##    maxnodes mtry     RMSE
## 1       100   15 6.382557
## 2       200   15 6.400786
## 3       500   15 6.453141
## 4       100   25 6.438546
## 5       200   25 6.398367
## 6       500   25 6.432645
## 7       100   35 6.406031
## 8       200   35 6.421510
## 9       500   35 6.406446
## 10      100   45 6.344892
## 11      200   45 6.435808
## 12      500   45 6.346776
## 13      100   55 6.423519
## 14      200   55 6.411626
## 15      500   55 6.340520
```

```
pars[which(RMSEs==bestRMSE),]
```

```
##    maxnodes mtry
## 15      500   55
```

```
yhat.rf1.train = predict(rf1)
yhat.rf1.test = predict(rf1, newdata = test.df)
RMSE.rf1.train = RMSE(train.df$W.L..next_year,yhat.rf1.train)
RMSE.rf1.test = RMSE(test.df$W.L..next_year,yhat.rf1.test)
data.frame(train=RMSE.tree1.train,test=RMSE.rf1.test)
```

```
##      train     test
## 1 3.857545 7.158891
```

```
# imp <- as.data.frame(varImp(rf1))
# imp <- data.frame(overall = imp$Overall, names = rownames(imp))
# imp[order(imp$overall, decreasing = T),]
```

```
library(randomForest)
set.seed(139)
maxnodes = c(100,200,500)
mtry = c(1,2,3)
ntree=200
pars = expand.grid(maxnodes=maxnodes,mtry=mtry)
RMSEs = rep(NA,nrow(pars))
bestRMSE = sd(train.df$W.L..next_year)

for(i in 1:nrow(pars)){
  rftemp = randomForest(W.L..next_year ~ W.L..same_year + Age.pitch + WHIP, data=train.df,
                        mtry=pars$mtry[i], maxnodes=pars$maxnodes[i], ntree=ntree)
  RMSEs[i]=RMSE(train.df$W.L..next_year, rftemp$predicted)
  if(RMSEs[i]<bestRMSE){
    best_maxnodes = maxnodes[i]
    bestRMSE=RMSEs[i]
    rf2=rftemp
  }
}
data.frame(maxnodes=pars$maxnodes,mtry=pars$mtry,RMSE=RMSEs)
```

```
##   maxnodes mtry     RMSE
## 1      100    1 6.689966
## 2      200    1 6.694802
## 3      500    1 6.694728
## 4      100    2 6.703474
## 5      200    2 6.748283
## 6      500    2 6.758374
## 7      100    3 6.741923
## 8      200    3 6.851817
## 9      500    3 6.857179
```

```
pars[which(RMSEs==bestRMSE),]
```

```
##   maxnodes mtry
## 1      100    1
```

```
yhat.rf2.train = predict(rf2)
yhat.rf2.test = predict(rf2, newdata = test.df)
RMSE.rf2.train = RMSE(train.df$W.L..next_year,yhat.rf2.train)
RMSE.rf2.test = RMSE(test.df$W.L..next_year,yhat.rf2.test)
data.frame(train=RMSE.tree1.train,test=RMSE.rf2.test)
```

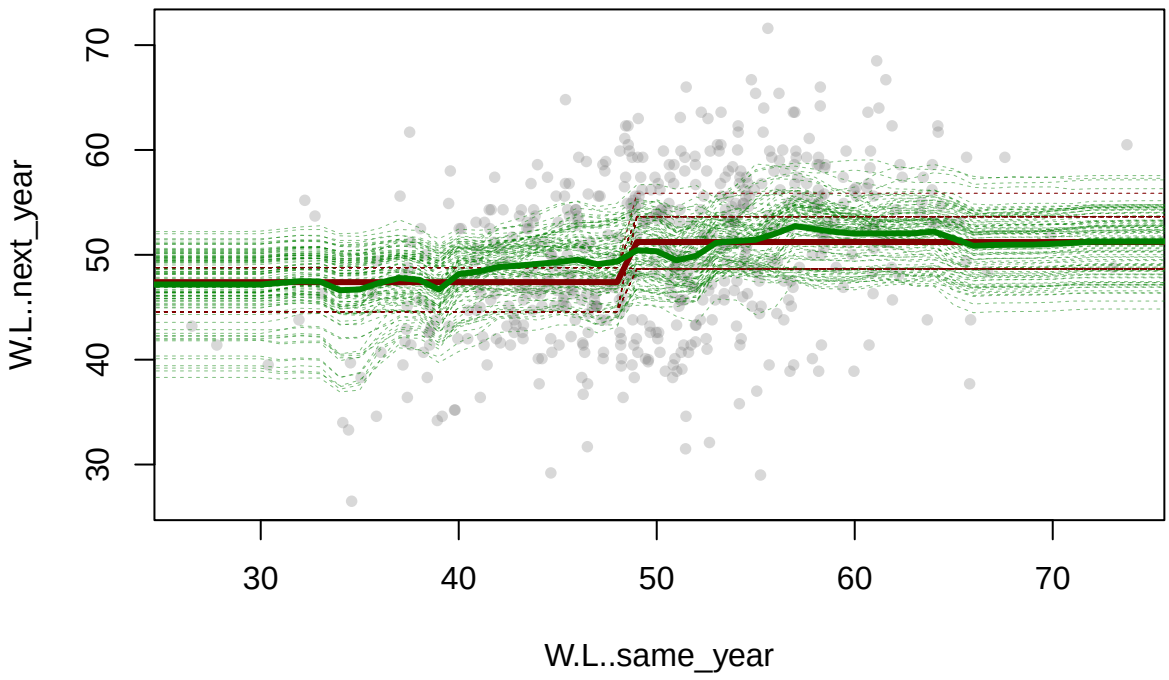
```
##      train     test
## 1 3.857545 7.321893
```

```
importance(rf2)
```

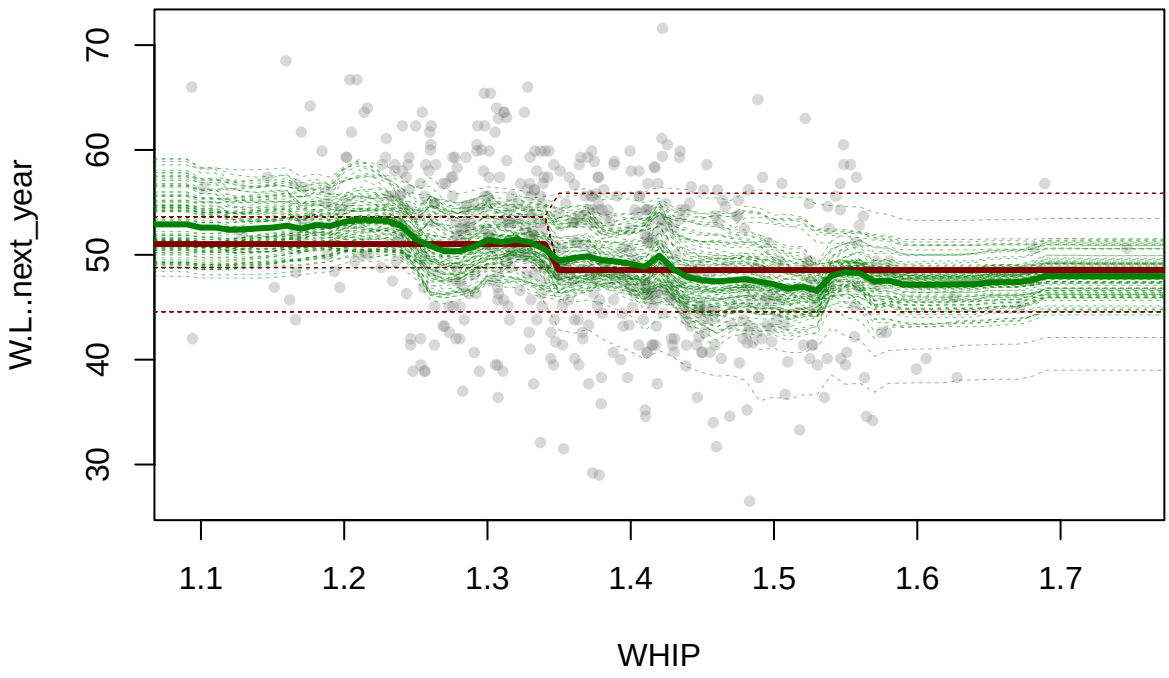
```
##                 IncNodePurity
## W.L..same_year       7706.259
## Age.pitch            6483.043
## WHIP                 7368.996
```

```
# imp <- as.data.frame(varImp(rf2))
# imp <- data.frame(overall = imp$Overall, names = rownames(imp))
# imp[order(imp$overall, decreasing = T),]
```

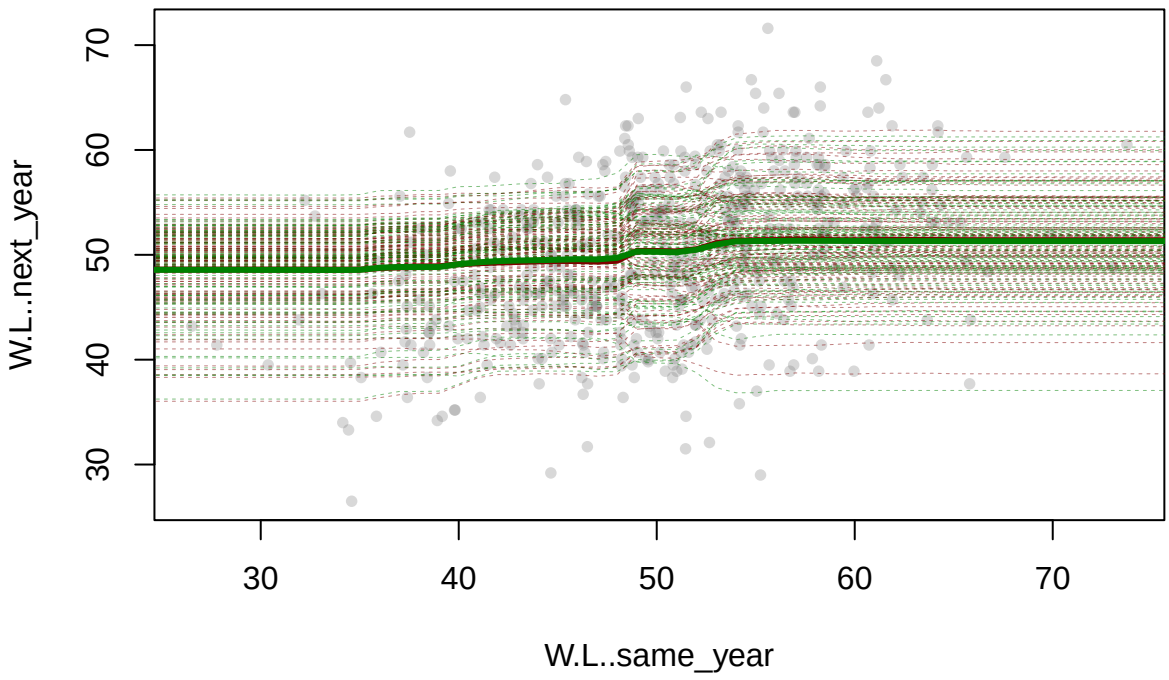
```
set.seed(139)
samp = sample(nrow(train.df),100)
dummy_df = train.df[samp,]
dummyx = seq(0,100,1)
plot(W.L..next_year~W.L..same_year, data=train.df,cex=0.8,pch=16,col=rgb(0.5,0.5,0.5,0.3))
yhats = matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
yhats.rf=matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
for(i in 1:nrow(dummy_df)){
  rows=dummy_df[rep(i,length(dummyx)),]
  rows$W.L..same_year=dummyx
  yhat = predict(tree4,new=rows)
  lines(yhat~dummyx,col=rgb(0.5,0,0,0.5),lwd=0.5,lty=2:3)
  yhats[i,]=yhat
  yhat.rf = predict(rf2,new=rows)
  lines(yhat.rf~dummyx,col=rgb(0,0.5,0,0.5),lwd=0.5,lty=2:3)
  yhats.rf[i,]=yhat.rf
}
mean_yhat = apply(yhats,2,mean)
mean_yhat.rf = apply(yhats.rf,2,mean)
lines(mean_yhat~dummyx,col=rgb(0.5,0,0,1),lwd=3)
lines(mean_yhat.rf~dummyx,col=rgb(0,0.5,0,1),lwd=3)
```



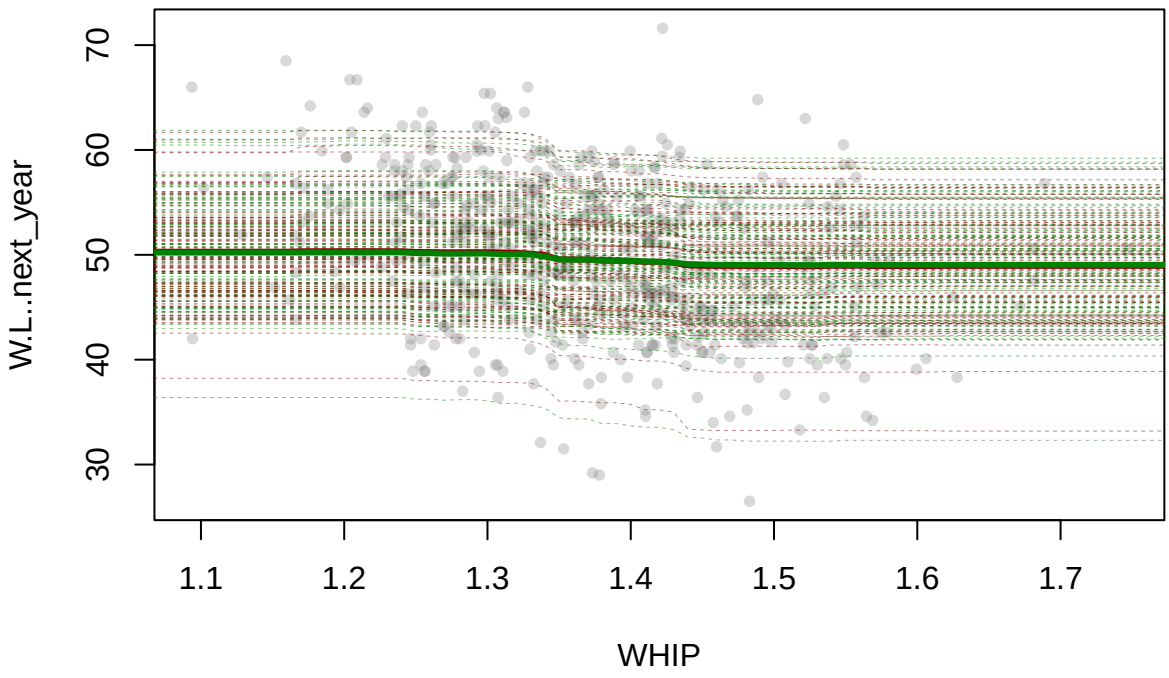

```
samp = sample(nrow(train.df),100)
dummy_df = train.df[samp,]
dummyx = seq(1,2,.01)
plot(W.L..next_year~WHIP, data=train.df,cex=0.8,pch=16,col=rgb(0.5,0.5,0.5,0.3))
yhats = matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
yhats.rf=matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
for(i in 1:nrow(dummy_df)){
  rows=dummy_df[rep(i,length(dummyx)),]
  rows$WHIP=dummyx
  yhat = predict(tree4,new=rows)
  lines(yhat~dummyx,col=rgb(0.5,0,0,0.5),lwd=0.5,lty=2:3)
  yhats[i,]=yhat
  yhat.rf = predict(rf2,new=rows)
  lines(yhat.rf~dummyx,col=rgb(0,0.5,0,0.5),lwd=0.5,lty=2:3)
  yhats.rf[i,]=yhat.rf
}
mean_yhat = apply(yhats,2,mean)
mean_yhat.rf = apply(yhats.rf,2,mean)
lines(mean_yhat~dummyx,col=rgb(0.5,0,0,1),lwd=3)
lines(mean_yhat.rf~dummyx,col=rgb(0,0.5,0,1),lwd=3)
```



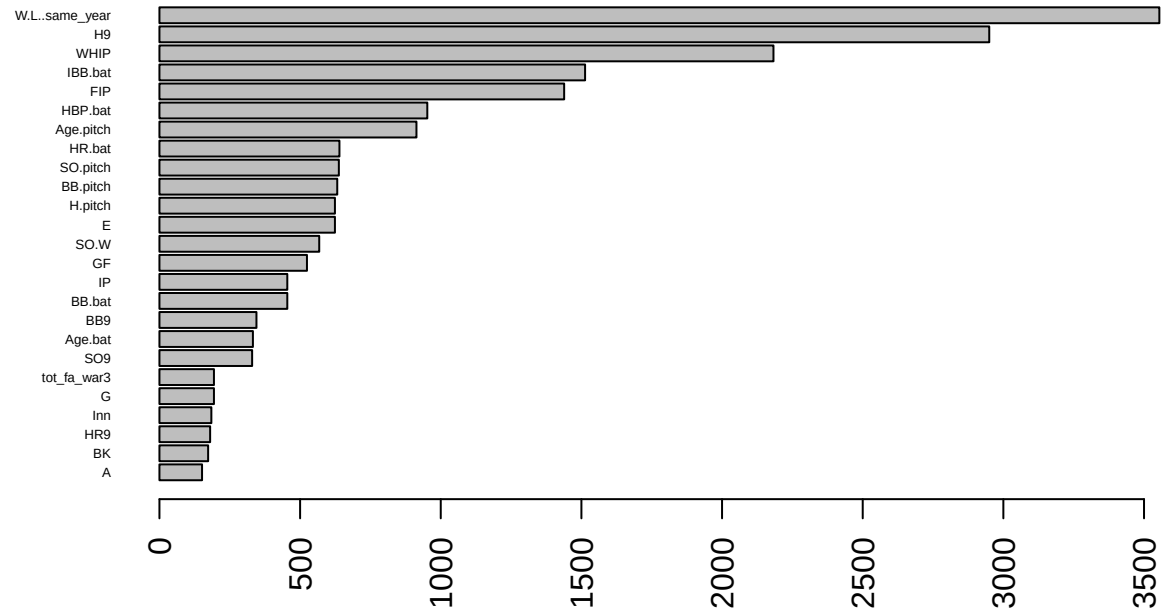

```
set.seed(139)
samp = sample(nrow(train.df),100)
dummy_df = train.df[samp,]
dummyx = seq(0,100,1)
plot(W.L..next_year~W.L..same_year, data=train.df,cex=0.8,pch=16,col=rgb(0.5,0.5,0.5,0.3))
yhats = matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
yhats.rf=matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
for(i in 1:nrow(dummy_df)){
  rows=dummy_df[rep(i,length(dummyx)),]
  rows$W.L..same_year=dummyx
  yhat = predict(bag,new=rows)
  lines(yhat~dummyx,col=rgb(0.5,0,0,0.5),lwd=0.5,lty=2:3)
  yhats[i,]=yhat
  yhat.rf = predict(rf1,new=rows)
  lines(yhat.rf~dummyx,col=rgb(0,0.5,0,0.5),lwd=0.5,lty=2:3)
  yhats.rf[i,]=yhat.rf
}
mean_yhat = apply(yhats,2,mean)
mean_yhat.rf = apply(yhats.rf,2,mean)
lines(mean_yhat~dummyx,col=rgb(0.5,0,0,1),lwd=3)
lines(mean_yhat.rf~dummyx,col=rgb(0,0.5,0,1),lwd=3)
```



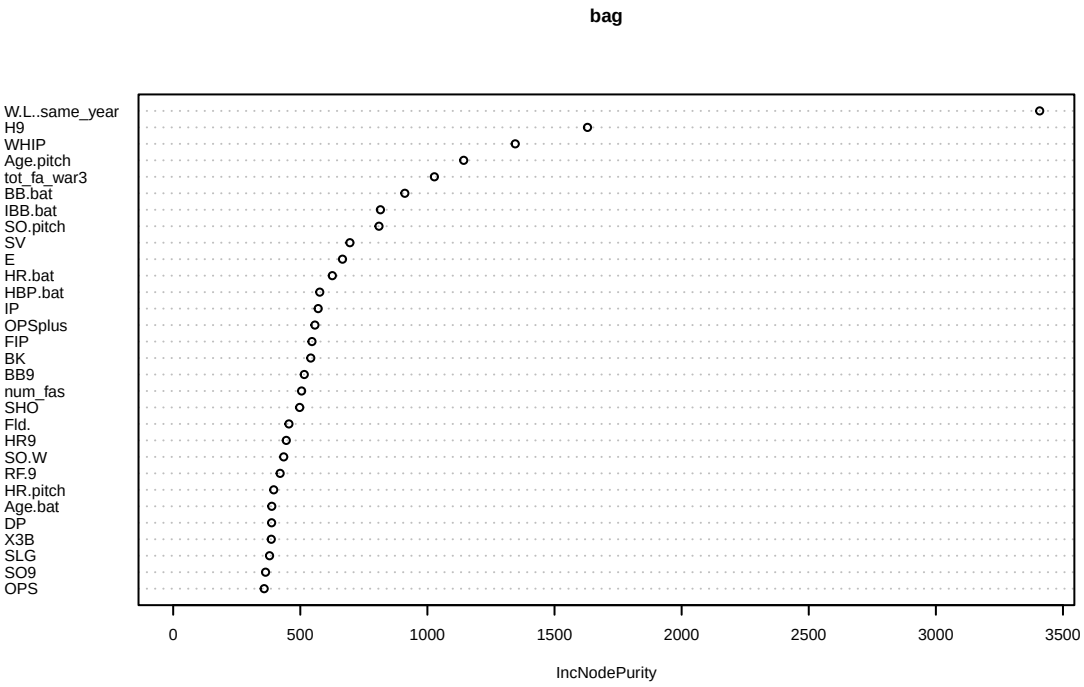

```
samp = sample(nrow(train.df),100)
dummy_df = train.df[samp,]
dummyx = seq(1,2,.01)
plot(W.L..next_year~WHIP, data=train.df,cex=0.8,pch=16,col=rgb(0.5,0.5,0.5,0.3))
yhats = matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
yhats.rf=matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
for(i in 1:nrow(dummy_df)){
  rows=dummy_df[rep(i,length(dummyx)),]
  rows$WHIP=dummyx
  yhat = predict(bag,new=rows)
  lines(yhat~dummyx,col=rgb(0.5,0,0,0.5),lwd=0.5,lty=2:3)
  yhats[i,]=yhat
  yhat.rf = predict(rf1,new=rows)
  lines(yhat.rf~dummyx,col=rgb(0,0.5,0,0.5),lwd=0.5,lty=2:3)
  yhats.rf[i,]=yhat.rf
}
mean_yhat = apply(yhats,2,mean)
mean_yhat.rf = apply(yhats.rf,2,mean)
lines(mean_yhat~dummyx,col=rgb(0.5,0,0,1),lwd=3)
lines(mean_yhat.rf~dummyx,col=rgb(0,0.5,0,1),lwd=3)
```



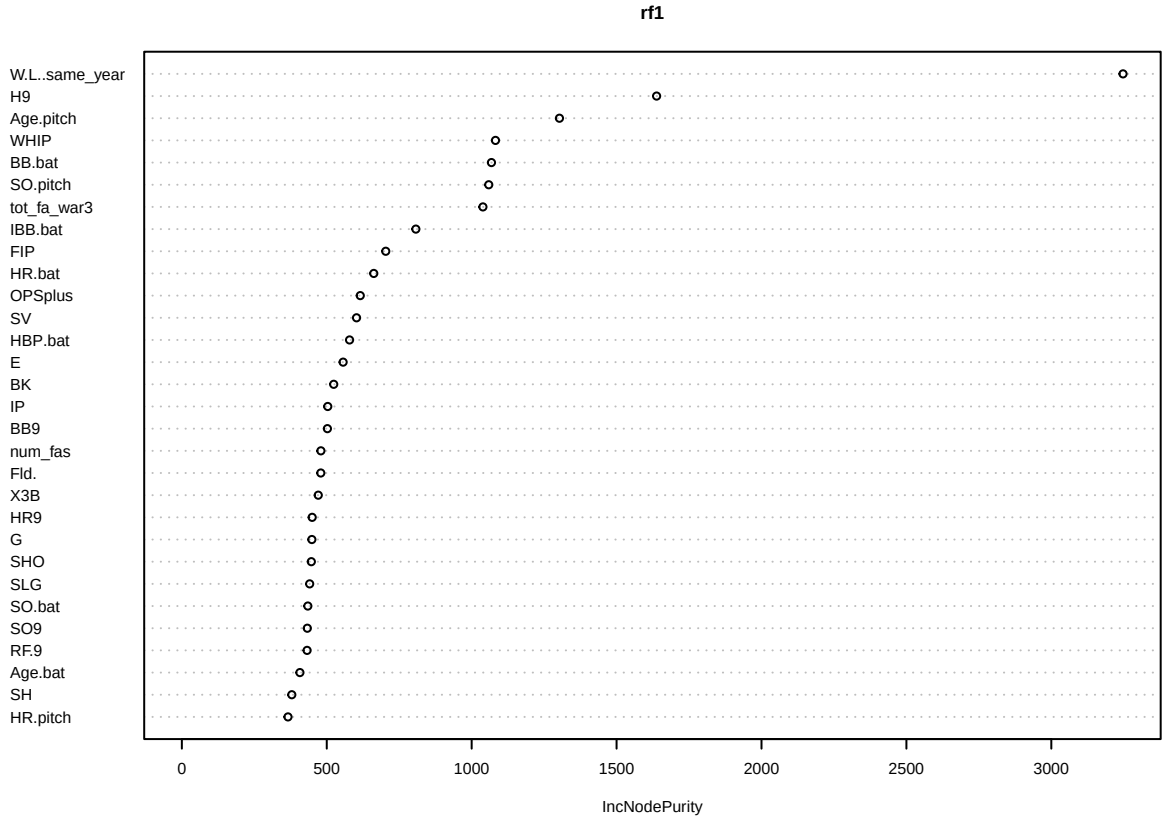

```
barplot(sort(tree2$variable.importance),horiz = T,las=2,cex.names = 0.4, main='Variable Importance for
```



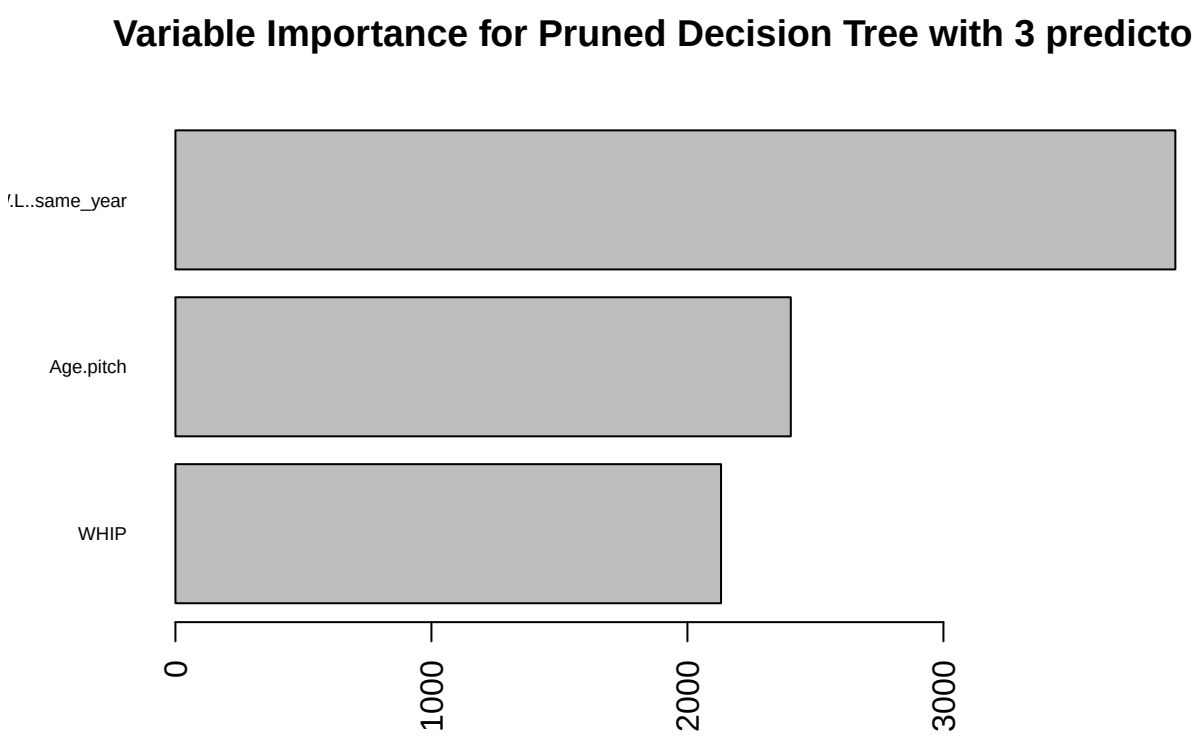

```
varImpPlot(bag, cex=0.5)
```



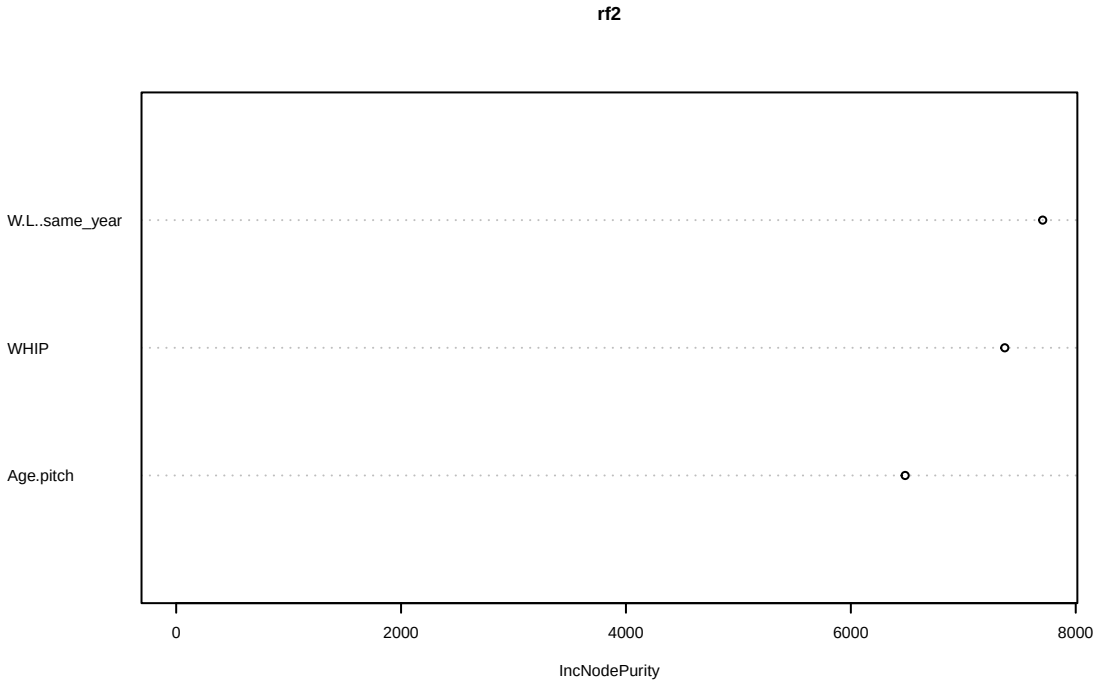

```
varImpPlot(rf1,cex=0.5)
```




```
barplot(sort(tree4$variable.importance),horiz = T,las=2,cex.names = 0.6, main='Variable Importance for
```




```
varImpPlot(rf2, cex=0.5)
```




```
tab <- matrix(c(RMSE.tree1.train, RMSE.tree1.test,
  RMSE.tree2.train, RMSE.tree2.test,
  RMSE.bag.train, RMSE.bag.test,
  RMSE.rf1.train, RMSE.rf1.test,
  RMSE.rf2.train, RMSE.rf2.test,
  RMSE.tree4.train, RMSE.tree4.test), nrow=6, byrow = TRUE
)
colnames(tab) <- c('train','test')
rownames(tab) <- c('tree1','tree2','bag', 'rf1', 'rf2', 'tree4')
tab <- as.table(tab)
tab
```

```
##          train     test
## tree1 3.857545 8.719118
## tree2 6.103694 8.010153
## bag   6.386760 7.146759
## rf1   6.340520 7.158891
## rf2   6.689966 7.321893
## tree4 6.529905 7.587558
```

```
library(lme4)
```

```
## Warning: package 'lme4' was built under R version 4.2.2
```

```
##
## Attaching package: 'lme4'
```

```
## The following object is masked from 'package:modeltools':
##
##     refit
```

```
set.seed(139)

# for (i in 1997:2022){
#   lmer_model <- lmer(team_data[[i]]$W.L.~poly(team_data[[i]]$BatAge, 2, raw = TRUE) + (1 + poly(team_
#   summary(lmer_model)
# }

lmer_model <- lmer(train.df$W.L..next_year ~ poly(train.df$Age.bat, 2, raw = FALSE) + (1 + poly(train.df
summary(lmer_model)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: train.df$W.L..next_year ~ poly(train.df$Age.bat, 2, raw = FALSE) +
##     ((1 | train.df$Tm) + (0 + poly(train.df$Age.bat, 2, raw = FALSE) |
##         train.df$Tm))
##
## REML criterion at convergence: 3572.2
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.8322 -0.6493  0.0081  0.6499  3.3522
##
## Random effects:
##  Groups        Name                                     Variance Std.Dev. Corr
##  train.df.Tm   (Intercept)                               12.20    3.493
##  train.df.Tm.1 poly(train.df$Age.bat, 2, raw = FALSE)1 397.08   19.927
##                poly(train.df$Age.bat, 2, raw = FALSE)2 425.04   20.617   -1.00
##  Residual                                               41.91    6.473
## Number of obs: 536, groups:  train.df$Tm, 29
##
## Fixed effects:
##                                     Estimate Std. Error t value
## (Intercept)                          49.8801     0.7147  69.795
## poly(train.df$Age.bat, 2, raw = FALSE)1  -0.6056     8.5193  -0.071
## poly(train.df$Age.bat, 2, raw = FALSE)2   7.0950     8.5057   0.834
##
## Correlation of Fixed Effects:
##                   (Intr) p(.$A.,2,r=FALSE)1
## p(.$A.,2,r=FALSE)1 -0.007
## p(.$A.,2,r=FALSE)2  0.028 -0.219
```

```
lmer_model <- lmer(train.df$W.L..next_year ~ poly(train.df$BA, 2, raw = FALSE) + (1 + poly(train.df$BA,
```

```
## boundary (singular) fit: see help('isSingular')
```

```
summary(lmer_model)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: train.df$W.L..next_year ~ poly(train.df$BA, 2, raw = FALSE) +
```

```
##     ((1 | train.df$Tm) + (0 + poly(train.df$BA, 2, raw = FALSE) |
##         train.df$Tm))
##
## REML criterion at convergence: 3561
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.7850 -0.6537  0.0028  0.6869  3.1663
##
## Random effects:
##  Groups        Name                                Variance Std.Dev. Corr
##  train.df.Tm   (Intercept)                         13.05    3.613
##  train.df.Tm.1 poly(train.df$BA, 2, raw = FALSE)1 28.48    5.336
##                poly(train.df$BA, 2, raw = FALSE)2 24.98    4.998    -1.00
##  Residual                                          41.77    6.463
## Number of obs: 536, groups:  train.df$Tm, 29
##
## Fixed effects:
##                                    Estimate Std. Error t value
## (Intercept)                         49.9380     0.7327  68.154
## poly(train.df$BA, 2, raw = FALSE)1  25.7781     8.7556   2.944
## poly(train.df$BA, 2, raw = FALSE)2  15.3337     6.8929   2.225
##
## Correlation of Fixed Effects:
##                     (Intr) p(.$BA,2,r=FALSE)1
## p(.$BA,2,r=FALSE)1  0.015
## p(.$BA,2,r=FALSE)2  0.006 -0.022
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
# lmer_model <- lmer(W.L..next_year ~ Age.bat + PA + AB + H.bat + X2B + X3B +
                # HR.bat + SB + CS + BB.bat + SO.bat + BA + OBP + SLG + OPS + OPSplus +
                # TB + GDP + HBP.bat + SH + SF + IBB.bat + Age.pitch + W.L..same_year +
                # GF + SHO + SV + IP + H.pitch + HR.pitch +
                # BB.pitch + IBB.pitch + SO.pitch + HBP.pitch + BK + WP + BF +
                # FIP + WHIP + H9 + HR9 + BB9 + SO9 + SO.W +
                # G + Inn + Ch + PO + A + E + DP + Fld. +
                # RF.9 + RF.G + tot_fa_war3 + num_fas || Tm, data = train.df, verbose=TRUE)
```

```
summary(lmer_model)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: train.df$W.L..next_year ~ poly(train.df$BA, 2, raw = FALSE) +
##     ((1 | train.df$Tm) + (0 + poly(train.df$BA, 2, raw = FALSE) |
##         train.df$Tm))
##
## REML criterion at convergence: 3561
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.7850 -0.6537  0.0028  0.6869  3.1663
##
## Random effects:
```

```
##  Groups        Name                                Variance Std.Dev. Corr
##  train.df.Tm   (Intercept)                         13.05    3.613
##  train.df.Tm.1 poly(train.df$BA, 2, raw = FALSE)1 28.48    5.336
##                poly(train.df$BA, 2, raw = FALSE)2 24.98    4.998    -1.00
##  Residual                                          41.77    6.463
## Number of obs: 536, groups:  train.df$Tm, 29
##
## Fixed effects:
##                                   Estimate Std. Error t value
## (Intercept)                        49.9380     0.7327  68.154
## poly(train.df$BA, 2, raw = FALSE)1  25.7781     8.7556   2.944
## poly(train.df$BA, 2, raw = FALSE)2  15.3337     6.8929   2.225
##
## Correlation of Fixed Effects:
##                     (Intr) p(.$BA,2,r=FALSE)1
## p(.$BA,2,r=FALSE)1  0.015
## p(.$BA,2,r=FALSE)2  0.006 -0.022
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ WHIP + W.L..same_year + Age.pitch + (1 + WHIP + W.L..same_year +
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
# summary(lmer.varmodel)
# predict(lmer.varmodel)
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.960116
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.886005
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ WHIP + W.L..same_year + Age.pitch | Tm, data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
# summary(lmer.varmodel)
# predict(lmer.varmodel)
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.923797
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.881961
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ WHIP + W.L..same_year + Age.pitch + tot_fa_war3 | Tm, data = tra
```

```
## boundary (singular) fit: see help('isSingular')
```

```
# summary(lmer.varmodel)
# predict(lmer.varmodel)
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.86711
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.948674
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ WHIP + W.L..same_year + Age.pitch + H9 | Tm, data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
# summary(lmer.varmodel)
# predict(lmer.varmodel)
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.772446
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.886837
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ WHIP + W.L..same_year + Age.pitch + H9 + (1 + WHIP + W.L..same_y
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.794736 (tol = 0.002, component 1)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly unide
##  - Rescale variables?;Model is nearly unidentifiable: large eigenvalue ratio
##  - Rescale variables?
```

```
# summary(lmer.varmodel)
# predict(lmer.varmodel)
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.772317
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.847728
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ Age.bat + PA + AB | Tm, data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 4 negative eigenvalues
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 6.094448
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.351492
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ Age.bat + PA + AB + (1 + Age.bat + PA + AB | Tm) , data = train.
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.803682
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.333509
```

RIDGE full

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ OBP + Fld. + BA + (1 + OBP + Fld. + BA | Tm) , data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.00274292 (tol = 0.002, component 1)
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 6.010713
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.401806
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ OBP + Fld. + BA | Tm , data = train.df)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.955088
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.429847
```

RIDGE full interaction

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ Fld. + OBP:Fld. + BA:OBP + (1 + Fld. + OBP:Fld. + BA:OBP | Tm) ,
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.00282336 (tol = 0.002, component 1)
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 6.040828
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.326709
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ Fld. + OBP:Fld. + BA:OBP | Tm , data = train.df)
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.9721
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.368868
```

LASSO full

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ OBP + WHIP + Fld. + (1 + OBP + WHIP + Fld. | Tm) , data = train.
```

```
## boundary (singular) fit: see help('isSingular')
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.680272
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.574778
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ OBP + WHIP + Fld. | Tm , data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.0024665 (tol = 0.002, component 1)
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.667373
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.610171
```

LASSO full interaction

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ SHO:IBB.pitch + OBP:Age.pitch + BK:HR9 + (1 + SHO:IBB.pitch + OBP
```

```
## boundary (singular) fit: see help('isSingular')
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 6.037307
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.366701
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ SHO:IBB.pitch + OBP:Age.pitch + BK:HR9 | Tm , data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.00450608 (tol = 0.002, component 1)
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.986946
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.310918
```

Random Forest 1 and Random Forest 2

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ W.L..same_year + WHIP + Age.pitch | Tm , data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.922331
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.915431
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ W.L..same_year + WHIP + Age.pitch + (1 + W.L..same_year + WHIP +
```

```
## boundary (singular) fit: see help('isSingular')
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.968995
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.894232
```

Prunded Decision tree with 3 Predictors

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ W.L..same_year + WHIP + Age.pitch | Tm , data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient

## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.922331
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.915431
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ W.L..same_year + WHIP + Age.pitch + (1 + W.L..same_year + WHIP +
```

```
## boundary (singular) fit: see help('isSingular')
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.968995
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.894232
```

Pruned Decision tree with all predictors

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ W.L..same_year + WHIP + H9 | Tm , data = train.df)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.83163
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.884966
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ W.L..same_year + WHIP + H9 + (1 + W.L..same_year + WHIP + H9 | Tm
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.897572
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.846031
```